ARMED FORCES CHEMICAL JOURNAL

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The members of this Association, mindful of the vital importance to national defense of chemistry, allied sciences, and the arts derived from them, have joined together as a patriotic obligation to preserve the knowledge of, and interest in, national defense problems derived from wartime experience; to extend the knowledge of, and interest in, these problems; and to promote cooperative endeavor among its members, the Armed Services, and civilian organizations in applying science to the problems confronting the military services and other defense agencies, particularly, but not exclusively in fields related to chemical warfare. (From Art. II, AFCA Constitution.)

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POLICY

The fact that an article appears in this magazine does not indicate approval of the views expressed in it by any one other than the author. It is our policy to print articles on subjects of interest in order to stimulate thought and promote discussion; this regardless of the fact that some or all of the opinions advanced may be at variance with those held by the Armed Forces Chemical Association, National Officers, and the Editors. It is the responsibility of contributors, including advertisers, to obtain security clearance, as appropriate, of matter submitted for publication. Such clearance does not necessarily indicate indorsement of the material for factual accuracy or opinion by the clearing agency.

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Chart No. 2 pg. 18, courtesy Sir C. F. Goodeve.

FRONT COVER

With the Navy in the role of "Host Service" for A.F.C.A.'s Annual Meeting in Washington this month, it seems especially fitting, by way of salute, to present on our Front Cover the picture of the new Navy Flag.

This is the first official flag of the Navy in all its 184 years history.

The design, submitted by The Honorable Thomas S. Gates, Jr., formerly Secretary of the Navy, now Deputy Secretary of Defense, was approved by President Eisenhower by Executive Order dated April 24, 1959. The center device is the inner pictorial portion of the official seal of the Department of the Navy.

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A.F.C.A. AFFAIRS

THE 14th ANNUAL MEETING OF A.F.C.A.

BY THE TIME of publication of this number of THE JOURNAL A. F. C. A.'s Fourteenth Annual Meeting, held at the Statler-Hilton, Washington, D.C., September 10-11, will have become the latest chapter of the Association's history.

Judging from the program, which was firm as of this writing (August 10) as to subject matter, events and names of speakers, this meeting - with the Navy in the role of "host service" - will have staked a strong claim to a verdict and label of "Outstanding," and so to rank with the best of those of recent years.

A full report of the meeting including narrative of the proceedings in general, condensations or full texts of the addresses as coverage and magazine space permit, and also pictures taken at the meeting will be presented in November-December number of THE JOURNAL. This number will be No. 6, completing the current volume, XIII.

Members or guests at the meeting who may wish additional copies of the November-December issue or reprints of any of the speeches should send their requests, in advance of publication of the issue, if possible, in order to facilitate compliance, to A. F. C. A. Headquarters, attention Secretary-Treasurer. A charge for additional copies is made by the Association: for members 50 cents per copy and for non-members $1.00. Reprints are provided at cost plus a small handling charge, the price depending upon the number of pages and the number of reprints (minimum 100 copies).

The compact though highly diversified program for this meeting presented several novel features. All scheduled speeches were listed for the morning sessions and were limited to 20 or 25 minutes. Afternoons were devoted largely to visits to Naval installations in the Washington area - the Naval Research Laboratory and the David Taylor Model Basin. To provide two full days for the general membership program, the Board of Directors held their semi-annual fall meeting on September 9, the day before the general meeting opened. Their business session was preceded by a dinner at the Army & Navy Club. The general business session of the meeting was scheduled for the last period of the first day, September 10, following return of the members from their visit to the Naval laboratory. It was expected that a substantial part of this one-hour period would be devoted to a presentation by Major General Marshall Stubbs, the Chief Chemical Officer of the Army, and the Association's Honorary President.

All four of the Armed Forces - Navy, Marine Corps, Army and Air Force - were included on the program, the speaking time being distributed generally equally among them. An exception to the otherwise all-Defense Department program was the listing of Dr. C. E. Waring, of the University of Connecticut. The listed banquet speaker, for the night of September 11, was Dr. G. P. Sutton, Chief Scientist of the Advanced Research Projects Agency of the Department of Defense. His subject was "Chemical Research and Advanced Military Developments." The agency is charged, among other duties, with coordination of Department of Defense work on missiles and space research.

ANNIE SUE BROWN, ATLANTA SCIENCE SPECIALIST, WINNER OF A.F.C.A. $1,000 AWARD FOR 1959

Mrs. Annie Sue Brown, Curriculum Specialist in Science of the Atlanta, Georgia, public school system, is the 1959 winner of A.F.C.A's $1,000 Award to an outstanding secondary school science teacher or supervisor. Friends of Mrs. Brown will not be surprised to learn of her recognition. From the time she received her B.S. in science at State Teachers College in Virginia and her Master's degree in Biology at Atlanta her career has been a series of successes. Her course has been a path marked by the success of her students under all types of competition. It is not surprising to learn that in 1958 she was selected by the Georgia Academy of Science as "Woman of the Year in Education."

The A.F.C.A. Award for 1959 consists of a check for $1,000 and a scroll. Candidates for the Award are named by A.F.C.A. chapters and a choice among them is made by the Awards Committee at National Headquarters. The selection of Mrs. Brown by the Award Committee was unanimous.

At press time of THE JOURNAL it could not be ascertained whether Mrs. Brown would be present to receive the award in person when it was announced at the Association's Banquet at the Hotel Statler, September 11, 1959, in Washington, D.C.

Industrial Chemicals • Agricultural Chemicals • Plastics • Magnesium

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

A.F.C.A. MEETING PROGRAM

Thursday 10 September 1959

Service	Speaker	Time	Subject
Navy (ONM)	VADM E. W. Claxton, USN	0930	Welcome Aboard
Mar Corps (R&D)	Brig. Gen. G. R. E. Shell	0945	Marine Corps Requirements of the Chemical Industry
Navy (Ships)	CDR. T. B. Owen, USN	1005	Preservative and Strippable Coatings
Army (Chem)	Lt. Col. T. E. Carew	1025	Radioactive Materials; Handling and Decontamination of
	Coffee Break	1045-1100	
Air Force	Maj. General M. C. Demler	1100	Air Force Requirements of the Chemical Industry
Air Force	Dr. A. E. Prince	1120	Chemical Problems in Space Travel
Air Force	Mr. W. Kniffen	1140	High Temperature Structural Materials
Army (Sig)	Mr. N. A. Terhune	1200	Dielectric Materials
Navy (Ships)	CDR. B. Inman, USN	1220	Thermal Generation of Electricity

Friday 11 September 1959

Army (R&D)	Lt. General Arthur G. Trudeau	0900	Army Requirements of the Chemical Industry
Navy (NOL)	Dr. E. C. Noonan	0925	High Energy Fuels (Solid)
Army (ORD)	Dr. W. A. Riehl	0950	High Energy Fuels (Liquid)
Air Force	Mr. E. Bartholomew	1015	Hydraulic Fluids
	Coffee Break	1045-1100	
Navy ACNO (Dev.) Dr. Guided Missiles	RADM K. S. Masterson	1100	Navy Requirements of the Chemical Industry
Navy (AER)	Mr. Martin Devine	1125	High Temperature Lubricants
Navy (ONR)	Dr. L. W. Butz	1150	Plastics
Univ. of Conn.	Dr. C. E. Waring	1215	The Phenomena of Fissure Burning and Flashdown in Solid Propellants
Navy (Pers)	RADM G. S. Rosso	1930	Invocation
DOD (R&E)	Dr. G. P. Sutton	2030	Chemical Research and Advanced Military Developments

ROCKY MTN. CHAPTER HEARS ARMY SCIENTIFIC DIRECTOR

The Rocky Mountain Chapter of the Armed Forces Chemical Association closed its 1958-59 season with a dinner meeting held at the Officers' Open Mess, Thursday evening, 18 June 1959.

The featured speaker Dr. Richard A. Weiss, Scientific Director of the Army Research Office, was introduced by Colonel William J. Allen, Jr., Commanding Officer of Rocky Mountain Arsenal, and President of the Rocky Mountain Chapter A. F. C. A. The subject of Dr. Weiss' address was "ARMY RESEARCH AND DEVELOPMENT."

Colonel Allen received a plaque from the Armed Forces Chemical Association for Meritorious Service - 1959, in recognition of his successful revival of the Rocky Mountain Chapter which had been inactive for many months before Colonel Allen arrived at Rocky Mountain Arsenal.

Among those who joined Colonel Allen and Dr. Weiss at the speaker's table were: Colonel Pierre A. Kleff, Deputy Commander, Rocky Mountain Arsenal, Dr. Fred Brown, National Bureau of Standards, Mr. Thomas G. McKenna, Plant Superintendent, Shell Chemical Corporation, Major General J. T. Bohlender, Commanding General, Fitzsimmons Army Hospital, Brig. General J. H. Rothschild, U. S. Army (Retired), Mr. Willard G. Axtell, Shwayder Brothers, Inc., Dr. B.E. Lauer, professor of Chemical Engineering, Colorado University.

Those seated at the speaker's table in the above picture are, from left to right: Dr. Weiss, Colonel Allen, Brig. General Rothschild, Mr. Axtell, Colonel R. C. Zalesky, Commanding Officer, Colorado Sector, XVI Corps, Dr. Lauer, Dr. Murlin Howerton, Chemical Engineering Department, University of Denver, Dr. Larry Ferreiva, Director of Research, Coors Ceramic Company, Golden, Colorado, and Mr. Knowles C. Clifton, Vice President, Rocky Mountain Chapter.

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HANDKERCHIEF OR TURKISH TOWEL FOUND GOOD PROTECTION AGAINST BOTH BW AND RAD AGENTS

If a radiological or biological attack occurs, a good way to keep harmful particles from entering the nose or mouth, if a modern gas mask is not available, is to shield them with a man's cotton handkerchief folded into eight layers or a turkish bath towel folded once, according to scientists of the U.S. Army Chemical Corps' Biological Warfare Laboratories, Fort Detrick, Md., and the U.S. Atomic Energy Commission, Germantown, Md.

These two articles, when used as specified, are at least 85 per cent efficient, tests showed.

A man's handkerchief folded the usual way into 16 layers or crumpled is a more efficient filter, the scientists reported. However, it is not recommended because, in these forms, it offers high resistance to breathing.

Ordinary toilet tissue is also more efficient than the recommended articles, but it is considered unsuitable for prolonged usage because accumulated moisture from the breath may cause it to tear.

Wetting these articles and others of cloth was ruled inadvisable because it makes resistance to breathing extremely high.

Eighteen variations of eight household and personal articles were tested for effectiveness as emergency respiratory protective devices in a chamber filled with particles to simulate biological aerosols and radioactive dust.

The tests were conducted at the Biological Warfare Laboratories under a contract supported by the Atomic Energy Commission's Division of Biology and Medicine.

Other variations of the man's handkerchief and the towel, as well as other test items, including a muslin bed sheet, a cotton shirt, a woman's handkerchief, cotton dress material and a rayon slip, proved less adequate for use as filters.

These conclusions are reported in the August 7, 1959 issue of the "Archives of Industrial Health," a publication of the American Medical Association. The authors of the report are H. Gerald Guyton and Herbert M. Decker of the Biological Warfare Laboratories and George T. Anton of the Atomic Energy Commission.

INDUSTRIAL COLLEGE OF ARMED FORCES OFFERS FREE CORRESPONDENCE COURSE FOR CIVILIANS AND MILITARY

WASHINGTON, D.C.—You don't have to wear a uniform to "attend" one of the nation's most senior joint military colleges.

The Industrial College of the Armed Forces, Fort Lesley J. McNair, Washington, D.C., offers a graduate level correspondence course to qualified civilians in business, industry, and the professions as well as selected officers of the reserves and of the regular components. This course is based on the curriculum of the 10-month resident course conducted by the college for selected senior officers of the military service and executives of the civilian agencies of the government.

The Industrial College, which operates under the direction of the Joint Chiefs of Staff, is unique among military colleges of the world in that it studies the economic readiness of nations and blocks of nations to wage war, and analyzes the economic, military, political, and psychological factors as they relate to the national security.

The correspondence course, "The Economics of National Security," portrays the interdependence of the economic and military structures. The text material is presented in 22 bound volumes of about 85 pages each, and is organized into five units of study. Members of the faculty review each test paper submitted and are available to answer individual questions. The entire course takes about one year to complete.

Since the course was first formulated in 1950, it has been repeatedly modified to reflect the changes in the world situation. Today over 3600 are enrolled in the course. Many major industries and companies recommend the course as part of their executive development program.

Civilians who successfully complete the course receive a certificate of completion. Reserve officers not on extended active duty are granted 48 credit points. There is no charge for the course.

Personnel interested in taking the course are urged to apply to the Commandant, Industrial College of the Armed Forces, Washington 25, D.C., Attn: Correspondence Branch.

GEN. SAYRE, HONOR GUEST AT CINCINNATI CHAPTER DINNER

The annual meeting of the Cincinnati Chapter of A. F. C. A. was held on June 4, 1959, at the Hotel Alms. The speaker and guest of honor was Brig. General Clifford L. Sayre, USAR, National President of A. F. C. A., and currently an executive with Food Machinery & Chemical Corporation, of New York City.

A reception for General Sayre was held prior to the dinner meeting, to which Chapter members, their wives and guests were invited.

The newly elected Cincinnati Chapter officers for the ensuing year were announced at the meeting by Mr. F. L. Diehl, retiring Chapter President, as follows:

President: Mr. L. Calvin Palmer, Vulcan-Cincinnati, Inc.

Ist Vice President: Mr. C. E. Trotter, American Laundry Machinery Co.

2nd Vice President: Mr. C. H. Orr, The Procter & Gamble Co.

Directors: Messrs. Owen Carter, The Procter & Gamble Co.; R. D. Sheldon, Vulcan-Cincinnati, Inc., and Gordon Rich, Cincinnati Councilman.

Secy-Treas.: Mr. W. Pilcher, The Procter & Gamble Co.

During his visit in Cincinnati, General Sayre was guest of Vulcan-Cincinnati, Inc., and his itinerary included a tour of the new manufacturing facilities recently completed for Vulcan Manufacturing, an associate company.

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JAMES C. VICKERS is pictured here practicing his highly specialized skills in one of our country's great chemical plants. Mr. Vickers is typical of the thousands of expert workers in this field who are buying U.S. Savings Bonds regularly. Mr. Vickers uses his company Payroll Savings Plan to make regular contributions to the Peace Power of his country.

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THE SOVIET SUBMARINE

REAR ADMIRAL HOWARD A. YEAGER, USN
Acting Antisubmarine Warfare Readiness Executive

. . . When the chips were down you proved yourself in World Wars I, II and Korea. You will work for peace but you should understand the great military threat which we face today - the Soviet submarine.

Because you have proved yourselves in battle as well as in peace, and because of what you stand for, I want to outline to you today one of the greatest military threats which we face—the Soviet submarine, and the counter to this threat, United States anti-submarine warfare.

In dealing with the Soviet submarine and our anti-submarine warfare problem, it is profitable first to look at the nature of these as they fit into the role of sea-power.

Control of the sea-lanes provides, in military terms, internal lines of communications which run across the oceans of the world. These extend right to the port facilities of our allies and the very shores of potential enemies. This is true whether we are transporting the men, oil, munitions and hardware that are our sinews of strength, or actually striking from the sea with naval forces.

At this very instant, there are at sea almost seven thousand merchant ships of 1600 gross tons and over. More than four thousand of these are in the Atlantic and the Mediterranean.

In the main these are the ships of the Free World. The Free Nations are in many respects "have not" nations. We rely upon the bulk transportation of cargo, minerals, food stuffs, fuel to support our national economies and to make possible the production of the materials of war. The sea lines of communication bind together this free world community.

The sea covers more than 70 percent of the globe; the submarine is a relatively cheap weapon against the nations that need the sea.

The peace-time economy of our own United States requires annually the movement in and out of the United States of one trillion, one-hundred and twenty billion, one-hundred and fifty million short ton miles.

Part of this moves by air, but the great bulk moves by sea. Most people are vaguely aware of this fact, but not many know the sheer magnitude of the normal flow at sea. Air transport provides a share of this, but it is only two-tenths of one percent of the total . . .

We in the Navy have carefully studied the various means to protect this necessary flow of materials—studied in great detail. The studies indicate that it is simply beyond the bounds of possibility to airlift these masses and volumes for several reasons. One reason is the high cost of air transportation. If we double the proportion carried by air (still a small fraction) we more than double the cost. Another reason is the inability of aircraft now under development to carry the individual loadings which in many cases are necessary, and the third and most important reason is fuel. For an overseas air lift of any magnitude we must actually ship-lift fuel and pre-position it at the way stops and terminals. For example, an airlift of 6,000 miles requires the pre-positioning of fuel by sea of about three and one-half tons of fuel for each ton of pay load to be airlifted. So you can see that an enlargement of the airlift actually increases the sealift, rather than decreases it.

We have also studied the possibility of transporting below the sea in submarines. The result is quite similar to that encountered in the airlift. In limited situations and for specific purposes there is advantage, but it is physically and economically impossible to use this type of transportation for anything more than limited situations.

I do not mean by this statement to derogate either

This article consists of excerpts from an address before the Military Order of the World Wars at the Kansas City Club, Kansas City, Missouri, April 25, 1959.

the airlift or the submarine potential. When time is of the essence and the loadings are of the right magnitude, or in the case of the submarine, concealment is essential, there is no replacement for these specific limited means. They are finer than fine gold. Our studies showed that both the airlift and the sealift are required. Neither can replace the other for its specific purpose.

As a practical matter, however, we are stuck with defending the masses and volumes that flow on the surface of the water—this is the heart of our anti-submarine problem today. It is a problem familiar to you who have served in war, and it affected each of you, irrespective of your theatre, and your branch of service.

The principal threat to our sea lines of communication is the existence of a Soviet submarine force in being of about 450 submarines. Compare this to the submarine force which Hitler possessed when he commenced World War II.

This Soviet submarine force is the result of a building program unprecedented for a nation nominally at peace. The force is modern, well trained, and ably manned. Its primary target?—the ships both merchant and naval of the Free World. In addition, we can expect a growing capability of the Soviet submarine fleet to launch missiles against the continental United States and our overseas bases.

What is the nature of the beast?

The submarine shown at the top is a Soviet long-range submarine. This submarine is greatly improved over those which we faced in World War II.

In both World Wars I and II the submarine problem finally became manageable (and barely manageable) because the submarines of those periods were essentially surface ships with a limited capability to submerge. When submerged they were severely limited in both speed and endurance. While surfaced their hull was subject to detection by the human eye and later by radar.

Near the end of World War II, but fortunately, too late to influence the outcome, the Germans introduced the snorkel. This breathing tube permitted the submarine to operate its diesel engines and re-charge batteries without having to surface. Instead of exposing the entire hull, only the snorkel, an object the size of a wastebasket, was exposed . . . This drastically increased the detection problem . . . .

The Soviet submarine which we face today is equipped with this snorkel device. In addition, he has about twice the speed and three times the endurance of our World War II opponent. In terms of search problem and kill problem, this makes an opponent of an entirely different magnitude. The submarine is now 200 times as difficult to detect by eye or by radar when he is using his diesel engines.

Further, we can expect the Soviet to follow the United States' lead in producing nuclear submarines. This true submersible increases the anti-submarine problem by an order of magnitude.

The marriage of the missile and the submarine will create an entirely new capability—submerged strike from the sea against the land. The Soviets will be capable of following the United States' lead in planning nuclear powered submarines equipped to fire ballistic missiles submerged. This future capability will place an additional anti-submarine burden on the United States.

. . . Hitler commenced World War II with 57 submarines. He reached a maximum strength of 440 U-boats at the height of the Battle of the Atlantic. In the course of the war our enemies lost a total of 911 submarines.

Admiral Yeager, a native of Chapman, Kansas, was graduated from the Naval Academy in 1927. He has had extensive and varied service at sea and also on Staff assignments in the Navy Department.

Early in World War II, while in the Bureau of Ordnance, he organized a unit for the repair of battle-damaged warships, which won him a Commendation, with Ribbon, from the Secretary of the Navy. Later, as Executive Officer of the *USS NEVADA*, he was decorated for heroic service during the invasion of the Coast of France, and, subsequently in the Pacific, during the invasion of Iwo Jima and Okinawa Shima, he was twice awarded the Bronze Star Medal with Combat "V."

Among his assignments since the War has been that of Director of Transportation in the Bureau of Naval Personnel, in which capacity he received an Army Letter of Commendation and Ribbon from the War Department.

In 1947 he served as Assistant Chief of Staff to the Commander in Chief, Pacific Fleet, and the next year was Aide to the Chief of Naval Operations, Navy Department.

Admiral Yeager was graduated from the National War College in 1953, and thereafter he commanded the *USS DES MOINES* for ten months. In 1956 he was Commander Amphibious Command, U. S. Atlantic Fleet, and in 1958 reported for duty as Comander Amphibious Group FOUR.

Opposing this, the Allies commenced World War II with about 200 ocean escorts, and an equal number of anti-submarine aircraft. At the height of the anti-submarine war there were some 930 allied ocean escorts, and about 2,200 aircraft engaged in anti-submarine warfare.

In comparison we now face about 450 Soviet submarines. To oppose these, we have about 300 ocean escorts (a ratio of less than one to one), and about 720 ASW aircraft (a ratio of less than two to one). We do have one additional member of the anti-submarine team; our own anti-submarine submarines, of which we have about 80.

In summary then, we face a tough opponent, an opponent with significant numbers of capable submarines aimed primarily against our vital sea lines of communication. We are moving forward rapidly to cope with the increasing threat. Emphasis is being placed on research and development to improve our capability to detect submarines and kill them. We require adequate forces of ships, submarines and aircraft to employ this detection and kill capability. The readiness of our present forces is being stressed.

The Navy is placing great emphasis on anti-submarine warfare for just as sea power conditions strategy, so our ability to control the Soviet submarine will condition seapower . . . .

MATERIEL VS ENVIRONMENTS

By Alfred N. Bloch

Statistical Engineering Unit
U.S. Army Chemical Corps Engineering Command

To date, the "aging" of inanimate objects is still a relatively unexplored domain. Scientists and engineers agree that, for the time being, only the long-term exposure of a finished product to the typical environments will determine its suitability reliably. In the long run, however, such after-the-fact investigation is not satisfactory. This article develops the problem and describes and analyzes the state of the Art. In a second article, it will be shown how the Chemical Corps expects to generate and to apply the missing knowledge on "aging."

UNDER present conditions, we have to count on being, suddenly involved in warfare anywhere on the globe. It could be in Tibet or Timbuktu, in the Alaskan waters or somewhere in the Andes, or in any other area. With the two camps aligned as they are, preparedness is the password. Our troops must be clothed, equipped and seasoned to live and fight in any climatic environment, and they must have materiel available which can be stored and used anywhere in the world.

It has been established that man, if properly trained and supported, can adjust himself to any climatic condition, survive and even fight successfully for survival. During the First World War, for example, the Italian carabinieris battled the Germans Alpine troops successfully under arctic conditions in the icy high mountain chains of the Alps. During the Second World War, our troops adapted themselves to jungle life and jungle warfare at Guadalcanal and other tropical areas. And Rommel's armies made a very good showing of climatic adjustment during the famous African desert campaign. Of course, it has happened, too, that the environment proved to be the stronger element, but always in such cases when man was not properly equipped and conditioned to withstand it. Napoleon's and Hitler's Russian campaigns are the classic examples of such happenings. However, such climatic conditioning cannot be expected of military materiel, or of any product or equipment which is supposed to serve its purpose in a particular environment or any environment. The suitability of an item for storage and use on a global scale is a basic characteristic without which the item loses its value and its usefulness. It cannot be incorporated in an item of equipment after its manufacture.

Another phenomenon affects man and materiel alike: They "age" as they grow older. In organisms, the tissues are subject to changes with the passage of time, and when their vitality is used up, they die. In materiel, chemical reactions and physical changes take place which in the course of time, become noticeable as deteriorations. As a result, at some age, a piece of materiel does not serve its intended purpose anymore and is "dead" as far as its usefulness is concerned.

The medical sciences are very much concerned about the "aging" of man. For centuries, rejuvenation has been one of their aims - to not much avail. As far as longevity is concerned, they have made some progress. Of course, the creative phase of man is out of their hands, but through prenatal care, they attempt to secure the birth of "healthy" specimens with a high life expectancy. However, they are limited in their efforts. Essential characteristics of a new organism are based on heredity and escape their control. Thus, the medical sciences can only assist nature, not control it. They cannot prevent aging either, because in man it is a natural occurrence, for which to date they have no antidote. But they have been studying the processes which constitute "aging", and during man's lifetime, they help him to keep aging at a "normal" rate. Their goal is expanding the lifespan of an individual as much as possible, regardless of his usefulness. In fact, he is welcome and actually assisted to enjoy the autumn of his life, long after his usefulness has been exhausted.

As far as materiel is concerned, conditions are somewhat different. The engineers themselves are the creative elements in this area. Heredity does not affect their efforts. They conceive, design and manufacture - give birth to - the new product. Those products are lifeless, no humanitarian considerations enter the picture. The engineers can thus be pretty practical about them. The consumer, in particular the military establishment, is not interested in excessive longevity. At the present pace of progress in technology and at the present fluid state of our concepts on the conduct of warfare, materiel becomes obsolete in no time. As a rule, the useful lifespan of an item should therefore be limited (to ten years or less).

Thus, whenever the need for a new piece of materiel arises, the engineers should be given a useful life span requirement for the new item, and they should then be in a position to develop a design in which the aging features are under control and which would serve its intended purpose over the specified period - and not longer. Materiel which outlasts its expected useful life is over-designed, and, if the necessary knowledge on aging were available, the responsible design engineer would be guilty of wastefulness.

In engineering, the aging phenomenon has not yet been explored extensively and the control of aging has not yet been achieved. Medicine has devised means (advice and medication) to prevent man from getting old "before his time." Engineering recommends protective coatings and the like to slow up the aging or deterioration process of materials and materiel. Thus, both sciences have just scratched the surface of the problem.

They offer golden opportunities for a "break-through" in the aging area.

In engineering, the problem is difficult enough, but it is by far not as complex as the aging problem in medicine. We believe, therefore, a systematic well-planned investigation will lead to the much desired and much needed control of aging in materiel.

Ballistic requirements can be incorporated into the basic design of a shell. This means: As the shell takes shape on the drawing board, the design engineer can see to it, that it meets the required ballistic properties. We have the engineering knowledge needed for designing those ballistic properties into the shell. If the delay for the functioning of a grenade is specified, we can design without difficulty a fuze which meets this requirement. However, when it comes to the suitability of military materiel for storage and use on a global scale within, but not beyond a specified period of time, we are confronted with requirements which, for the time being, cannot be designed into a new item.

These requirements are concerned with the undesirable effects of climatic conditions - scientists and engineers call them environments - on a product. An item might be unsuitable for storage and/or use in one or more environments. Or an item might deteriorate prematurely in one or more or all environents. Thus, private industry, as well as the military establishment, is very much interested in detecting and defining the "environmental resistance features" of an item, those characteristics which render a product resistant to environmental stresses. Such knowledge would have an immediate wholesome effect on engineering design and manufacturing practices.

Of course, some experience has been gained on the behavior of materials and equipments in the various environments. But as far as environmental resistance features are concerned, the design of any new product is a gamble. The engineer does not know in advance whether or not the item can be stored and used in any desired environment, and how long it will serve its purpose.

In order to obtain an early indication of the environmental behavior of a new product, development prototypes of the item are subjected to so-called "accelerated surveillance" exposures. In special chambers, they are conditioned to the temperatures which are typical for the various climatic extremes. After a few weeks' storage in each particular condition, the products are put to use. If they survive this storage and serve their intended purpose, they are considered suited for the particular environment.

There have been instances where actual experience disproved this assumption. This is not surprising. In a desert surveillance chamber, for example, the test items are kept at a temperature of 160°F. They are exposed to just one climatic stress which is held constant over the whole exposure period. In the natural desert climate, they are exposed to the total environment, to a whole series of continuously varying stresses. In both cases, the test items will show indications of deterioration. But it is obvious that the chemical reactions generated in the one-stress artificial chamber climate and those generated in the multiple-stress natural climate are not identical. Thus, any similarity between exposures in the natural environment and exposures in the

(Continued on page 16)

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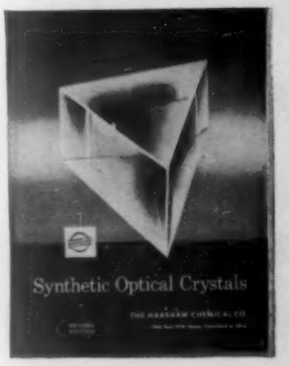

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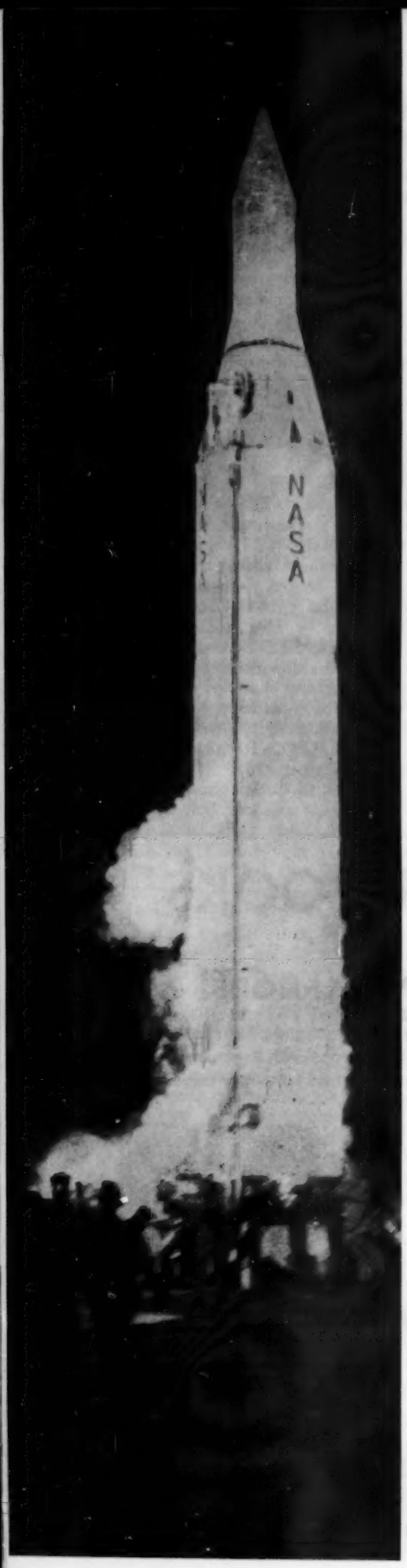

This is JUNO II, the launching vehicle for the Army's PIONEER III space probe, ready for takeoff for a try to the moon. The probe was conducted by the US Army under the technical direction of the National Aeronautics and Space Administration, on 5 December 1958.

SPACE VEHICLES— Materials and Propellants

By WILLIAM T. READ, SR.

PROBLEMS of materials of construction and of propulsion systems for all manner of what may be broadly termed "space vehicles" are of increasing interest to chemists and metallurgists. Such vehicles range from jet aircraft, as they replace piston planes, through ballistic and guided missiles and earth satellites to other devices that escape from the gravitational pull of the earth and venture forth into outer space. At one end of the scale are air-breathing power plants, and at the other those powered by propellants which are completely contained within the vehicle and are made up of fuels and oxidants.

Propellants must possess high capacity to produce energy at very high combustion temperatures. Materials of construction often must have the greatest possible mechanical strength with the lowest possible density, but must be able to withstand extremes of temperature as well as environmental stresses. Not only are construction materials subjected to high temperatures from the vehicle's power plant, but at the very high speeds being attained by the newer types of military aircraft, and particularly by rocket-propelled missiles, they must withstand severe aerodynamic heating.

This article does not attempt to go into the details of the numerous and very complex problems of space vehicles, its objective being to give a broad general picture of the fields of materials and propellants.

Materials of Construction

The main factor in determining the suitability of materials for construction of space vehicles is that of high temperature. Both high-temperature strength properties and thermal properties are the most important. In air-breathing power plants, the emphasis has been on turbine and compressor blades and wheels and on guide vanes. In rocket propulsion systems, attention is centered on high strength-low weight sheet components, rocket nozzles and associated guidance components, and on reentry cones. Turbine inlet temperatures are of the order of 1650°F to 1800°F, while combustion temperatures in rocket propulsion systems are over 5000° F. Aerodynamic heating during reentry, to which nose cones are subjected, produces temperatures above the melting points of most materials. Hypersonic aircraft may be subjected to similar but somewhat lower temperatures. It should be noted, however, that components of gas turbines must stand up for hundreds of hours, while exposure times of materials in rocket propulsion systems are much shorter, ranging from a few seconds to a few hours. High strength properties are no less important in missiles, satellites, and outer space vehicles than in military and commercial aircraft, but thermal properties are receiving an increasing amount of emphasis. Among these are specific heat, heat transfer, thermal conductivity and emissivity, and coefficients of thermal expansion.

With these general requirements in mind, a brief review of materials may be conveniently divided into these three classes.

a) Intermediate Temperature Use (300°F to 1200°F)

b) High Temperature Use (1200° F to 1800°)

c) Ultra High Temperature Use (Above 2000°F)

a) In the first class, aluminum and magnesium alloys have found extensive usage at temperatures up to about 500°F. Above this temperature strength properties begin to drop rapidly. However, the use of insulation and other temperature-alleviation systems make their continued use, even at high temperatures, more promising. Titanium is

(*Continued on page* 26)

Scientists research constantly to improve or design new safety equipment . . .

Tool-makers, with experienced hands, skillfully manufacture production tools . . .

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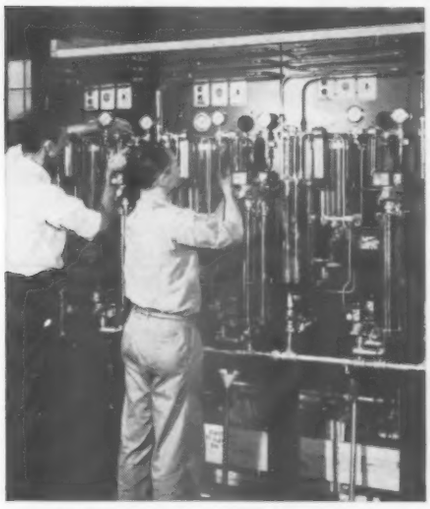

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"ORGANIZING FOR WAR", FIRST OF HISTORY SERIES OF CHEMICAL WARFARE SERVICE IN WORLD WAR II, ON SALE

THE AUTHORS

Dr. Leo P. Brophy was born in McAdoo, Pennsylvania, in 1906. He graduated from Franklin and Marshall College in 1927 and later received master and doctor degrees in history from Fordham University. After teaching history and sociology at Fordham and Seton Hall Universities he joined the staff of the Chemical Corps Historical Office in 1945. He has specialized in administrative and logistic history. Since 1953 Dr. Brophy has served as Chief of the Chemical Corps Historical Office.

Colonel George J. B. Fisher, co-author with Dr. Brophy of this volume, was born in Camden, N.J. in 1893. He was originally commissioned in the Artillery and served in that branch in World War I, joining the Chemical Warfare Service in 1929. Colonel Fisher was the author of a book, *Incendiary Warfare*. Following his retirement in 1947 he was engaged for several years as a historical consultant to the Chemical Corps. He died on January 11, 1956 at Fort Myers, Florida.

REVIEW BY COL. LACKAS*

United States Army in World War II. The Technical Services. The Chemical Warfare Service: Organizing for War *by Leo P. Brophy and George J.B. Fisher. Office of the Chief of Military History, Department of the Army, Washington, D.C., 1959.* By Col. John C. Lackas U.S.A., Industrial College of the Armed Forces.

THIS VOLUME, which is one of the series entitled UNITED STATES ARMY IN WORLD WAR II, is the first of three volumes on the Chemical Warfare Service scheduled for publication. The volume discusses the expanding mission of the CWS before and during World War II and the growth of an organization to carry out that mission. A second volume, entitled *From Laboratory to Field*, scheduled for early publication, deals with specific problems encountered in the research, development, procurement, inspection, and issue of chemical warfare munitions. A third volume, *Chemicals in Combat*, will cover chemical warfare activities in the theaters of operation.

In a foreword to this volume, Maj. Gen. R. W. Stephens, Chief of Military History, points out that in the pre-World War II period the Chemical Warfare Service, anticipating that in another conflict the Service would be principally concerned with gas warfare, concentrated on defense and retaliation against it. As a result, the United States was equally prepared as other nations for such warfare and this served as the principal deterrent to the use of gas.

The authors of the volume indicate that it was, in fact, the institution of gas warfare by Germany in World War I, which led to the establishment of the Gas Service, AEF, on 3 September 1917, and the subsequent creation of the Office of Gas Service within the War Department. Finally, the formal establishment in June 1918 of the Chemical Warfare Service, National Army, was accomplished by a War Department general order which provided for its continuance until six months after termination of hostilities. However, Congress extended the life of the CWS and in 1920 the National Defense Act of 1916 was amended by adding a section starting with the words, "There is hereby created a Chemical Warfare Service."

Following this enactment, the authors point out that

*See biographical note on page 16.

SALE BY A.F.C.A.

Arrangements have been made with the Government Printing Office whereby this volume of the Army official histories, "U.S. Army in World War II, The Technical Services, The Chemical Warfare Service: Organizing For War," by Dr. Leo P. Brophy and Col. George J. B. Fisher, may be procured through the Armed Forces Chemical Association. The price of this volume is $4.00.

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the mission of the Service was a subject of continuous debate by the War Department General Staff until the outbreak of World War II. During the interval between the two wars meager resources were made available to the Service, and these were devoted primarily to research and development, with least emphasis on training. This was particularly true during the emergency period prior to World War II.

With the appointment of Maj. Gen. William N. Porter as Chief, CWS, on 30 April 1941, the activities of the Service expanded considerably. It was General Porter who influenced the Air Corps to use incendiary bombs, and obtained from the War Department the exclusive responsibility for all phases of the incendiary bomb program for CWS. Porter also influenced the Chief of Staff to assign responsibility for biological warfare to the CWS. He also urged the employment of the 4.2-inch chemical mortar as the ideal weapon for delivering gas, smoke, or high explosive shells in high concentration in support of ground operations. Porter remained Chief of the CWS throughout the war and into the period of demobilization, retiring on 13 November 1945. The authors point out that he was an affable and diplomatic officer who had the capacity to quickly evaluate a complicated problem and reach a satisfactory solution with little effort. During his leadership of the Service there developed within his office a huge organizational structure as well as an extensive, geographically distributed, field organization consisting of procurement districts and inspection offices, as well as a considerably expanded Chemical Warfare Center at Edgewood, Maryland, where such activities as research, training, manufacturing and storage were conducted. During his term the arsenal activities of Edgewood were supplemented with arsenals at Huntsville, Pine Bluff, and Rocky Mountain, and an extensive depot and storage system was created. Training installations and facilities were established at Camp Sibert, Gadsden, Alabama, as a replacement center, where, in the fall of 1942, a Unit Training Center was activated; a chemical warfare school was established at Camp Beale, California, in July 1943, which was moved to Rocky Mountain Arsenal in June 1944.

Facilities for research and development were considerably expanded with the erection of a CWS laboratory on the campus of the Massachusetts Insitute of Technology and utilization of a laboratory at Columbia University. The testing facilities at Edgewood were supplemented with facilities at Dugway Proving Ground, Utah, and San Jose Island in the Caribbean.

Biological warfare installations were established at Camp Detrick, Maryland, at Horn Island off the Mississippi coast, and at Granite Peak, Tooele, Utah.

Considerable attention is given by the authors to the problems involved in the administration and management of the exploding number of civilian and military personnel added to the rolls of the CWS. Many difficulties were faced by the Service in the procurement, training, and assignment of this multitude of people. In the case of civilians, a most pressing problem was meeting the competition of other employers, particularly in regard to retaining workers. Considerable assistance was provided to the Service in the matter of administering civilian personnel at Edgewood by James P. Mitchell, then Chief of the Civilian Personnel Division, ASF, and who is presently the Secretary of Labor.

Throughout their discussion of the development of the Chemical Warfare Service the authors indicate the individuals participating in the various actions taken, and the nature of their contribution to the development and the conduct of the activities created. The description of the administrative development of the Service occupies approximately one-half of the volume. The second half of the book is concerned with the history and development of the military training responsibilities of the Service. This portion of the book begins with a discussion of the pre-war training responsibilities of the Service which were stated in the National Defense Act of 1920, to be: "supervision of the training of the Army in chemical warfare, both offensive and defensive, including the necessary schools of instruction," and "training—of special troops." This provision, as the authors point out, "furnished the basic pattern followed in CWS training during World War II."

Before the war, the most important single training agency for the Service was the Chemical Warfare School at Edgewood. As the authors indicate, "It was in effect the fountainhead of chemical warfare training for the Army and its teachings were closely followed in the Navy and Marine Corps." The school taught primarily the offensive and defensive aspects of gas warfare; military employment of smoke was treated briefly, and some consideration was given to incendiary warfare.

In September 1939, there were 90 officers and 759 enlisted men in the CWS and this small group constituted the hard core around which the tremendous expansion during the next four years was to develop.

During the period of partial mobilization the question of the combat functions of CWS was raised. It led to a disagreement between the Chief, CWS, then General Baker, and the War Department General Staff; the latter seeking to relieve the CWS of its combat functions and distribute them among infantry, cavalry, and engineer troops. While the dispute had to do with the exercise of the combat function, the crux of the matter was armament. The issue revolved around the status of the 4.2-inch chemical mortar. The CWS wanted this weapon retained; the General Staff wanted it replaced by the 81-mm mortar. The matter was resolved by General Marshall when he approved the activation of two battalions and directed the Chief, CWS, to include in fiscal year 1943 estimate funds to equip these two battalions with 4.2-inch mortars.

There was never any objection to "service" type chemical units. Three types were authorized at the beginning of the emergency period: laboratory, maintenance, and depot companies.

The training program during the period of partial mobilzation is described by the authors as "halting and confused," which they ascribe in part to the passive attitude of the War Department General Staff toward CWS training.

In regard to civilian defense, it is pointed out that the CWS had recognized its importance as early as 1930. However, it was not until May 1941 that a school for the training of civilians was activated. The Chemical Warfare School in the presentation of civil defense information conducted eleven classes prior to 7 December 1941, and trained 466 students from thirty-seven states. From among these students came many leaders to head civilian defense agencies throughout the country after war was declared. After the start of the war the civilian defense training activities considerably expanded and a variety of courses were offered at various colleges and universities throughout the country.

The authors provide a detailed account of the development and growth of the Chemical Warfare Service training responsibilities and programs for military personnel, which includes descriptions of replacement

training, the training of chemical units, the instruction of officer candidates, as well as an account of the growth and expansion of the Chemical Warfare School. This detailed and informative analysis of the training responsibilities and programs of CWS concludes with an account of the chemical warfare training of the U.S. Army, which, as the authors indicate, involved not only purely defensive training to withstand enemy gas attack, but also training in the offensive employment of chemical weapons. A full description of the initiation, development, and extent of antigas training of air and ground units is given, as well as a discussion of the training provided for the employment of flame, smoke and incendiaries. In the conduct of this training by the CWS, the service was handicapped by the attitude of ground force commanders, particularly, in regard to antigas training, for they were convinced that gas warfare was not imminent and therefore failed to emphasize this type of training. In contrast, the Army Air Forces were considerably more interested and concerned about defense against chemical attack as well as for tactical readiness of combat units for offensive action.

The authors conclude this account of the training of the Army for gas warfare which, they point out, was conceived as the primary training mission of CWS in the prewar years, by saying that it unexpectedly became a secondary mission during the war, while the training of service type units and replacements became the chief training responsibility during the war.

A number of appendices on specialized aspects of the history of the Chemical Warfare Service are provided by the authors. These include tables on personnel strengths, as well as Chemical Warfare Service World War II unit data.

This volume is indeed a comprehensive and informative history of the growth and development of the Chemical Warfare Service for war. It evidences considerable scholarly and critical research and is written in a clear and understandable style. Certainly, it is a significant and valuable addition to this important series of books on the United States Army in World War II.

*The author of this review, Col. John C. Lackas, USA, is a member of the faculty of the Industrial College of the Armed Forces where he is assigned to the Materiel Management Branch. It has been said that Colonel Lackas probably holds more academic degrees than any other Army Officer. He has a B.S., M.A., and Ph.D., from New York University; also an LL.B. and LL.M. from Rutgers University Law School, and a J.S.D. from St. John's University.

MATERIEL VS. ENVIRONMENTS

(*Continued from page* 11)

related artificial environment of conventional test chambers is purely coincidental.

It has been claimed in addition, that a few weeks' conditioning in climatic chambers corresponds to several years' exposure in the related natural environment. Obviously, such "correlation" does not exist, and it can be safely predicted, with present climatic chamber procedures, it is not likely to be achieved.

Granted, under the effect of the intensified stress, deterioration progresses more quickly in the chamber than in the natural environment, but since the two deterioration processes are of different nature, the "accelerated" aging in the climatic chamber is not of much help. We are interested in an acceleration which achieves the natural deterioration at a quicker pace than nature. The environmental engineer aims at the undistorted acceleration of the natural aging process. At the present state of our knowledge, this is scarcely possible.

Nevertheless, because of the lack of better modes of investigation, accelerated surveillance in one form or another has been generally accepted. It is included in specifications, used as an acceptance criterion for goods, and practised throughout industry. This in spite of the fact that it is well recognized too, that only the exposure of a product to the natural environment establishes its suitability for storage and use in the various climates. This involves a surveillance period of up to five years in each of the typical environments. In addition, just routine surveillance of the items will not yield the desired results. Surveillance in the natural climates will expand our special and general knowledge in the area of environmental engineering only if the test items are used for complex exploratory investigations by expert scientists and engineers. In the military establishment, this is indeed the goal, as outlined in AR 705-15.

However, by the time environmental surveillance is completed, the item has been mass-produced, and its failure in one or more environments is a costly affair. On the other hand, a product might pass accelerated surveillance and serve its intended purpose in all natural environments. Chances are, that such an item is considerably over-designed. And this is a characteristic which because of the unnecessary expenses involved is highly undesirable.

The weaknesses of the present practices in the environmental surveillance area are obvious. Economical and engineering considerations call for efforts toward the detection and definition of the "environmental resistance features" of products and for their incorporation in the basic designs. The problem is a matter of considerable concern to the military establishment, too. Realizing the need for more knowledge in the environmental area, the U.S. Army Chemical Corps Engineering Command is actively engaged in studies toward achieving this goal. How we plan to proceed will be shown in a second article.

CHESAPEAKE SECRETARY HONORED

Army Chemical Center, Md.—Mr. Charles J. Helmer (center) receives the Armed Forces Chemical Association plaque for Meritorious Service from Colonel Roy A. Muth (left), Commander of the Engineering Command here. The award recognized Mr. Helmer's work as secretary in establishing an excellent record for the first year's operation of the new Chesapeake Chapter. Witnessing the ceremony was Mr. George L. Cole, the chapter president.

"ARMED FORCES DEVELOPMENT UNITS"

A suggestion for keeping intact, in case of an emergency situation involving mobilization, of certain Reserve officer groups at universities, etc., ready for uninterrupted assignment to military research and development projects, is put forward and discussed here by—

DR. FREDERICK BELLINGER
Chief, Material Sciences Division
Georgia Institute of Technology,
Atlanta, Georgia

THE UNITED STATES has claimed and received world-wide credit for the use of research teams to solve tough research and development problems quickly and efficiently. Such teams are not built in a day, but are the happy result of years of effort in specific areas of research. Yet, in the event of a military emergency, and at the moment when the productive effort of such teams is most urgently needed, their research potential can be disrupted, as it has been in the past, by our own military system!

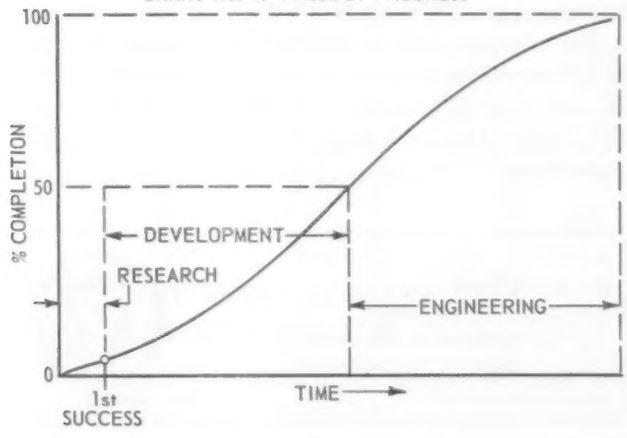
Many key research personnel are military reserve officers and hence subject to an abrupt call to military duty. (At Georgia Tech's Engineering Experiment Station, a recent count showed that of 28 of the Station's top technical personnel 12 are subject to call!) It seems obvious that the Nation would benefit more by being able to direct the abilities of such existing groups *immediately* into high priority work rather than to disperse the individuals to the services and *slowly* amalgamate them into the many separate organizations.

This article presents an idea of how, in the event of a national emergency, groups of scientists and engineers who have developed interrelated skills by working together for years can continue to work together with high efficiency.

Important Differences

In the past the words "research" and "development" have been used almost inseparably. Recently large organizations are enlarging the apparent scope of their activities by using the word combination "research and engineering." Many of the difficulties in the past would have been prevented if there had been full realization that the type of work, the personnel required and their training and the methods of administration are distinctly different for each phase: research, development, and engineering. Sure, there are gray areas where overlapping occurs briefly between each phase, but the great majority of effort applied and the time consumed fall within these distinct phases in the growth of an idea to a product.

CHART NO. 1. PROJECT PROGRESS



Research starts with an idea. "Pure research" is devoted to acquiring basic knowledge with no practical object in mind. "Applied research" has a specific objective—a problem to be solved or a need to be filled. Both kinds of research end with the first successful laboratory solution. One cannot truly estimate the time that will be needed to complete a research project.

Development is the work, usually in a hurry, to determine whether there is a practicable solution, and if so, to define and delineate the solution and to prepare an interim answer. The time required for development depends primarily upon the skill and ingenuity, the cooperation between scientists and engineers working as a team, and the rate of effort applied. See Chart No. 1.

Engineering perfects the efficiency and economy of the practicable development. The time required for engineering is determined by a compromise between the extent of effort required to obtain perfection, and the definition and acceptance of a satisfactory product.

Since there are these distinct differences between research, development, and engineering, different types of organizations and methods of operation are required for efficient work in each phase. This fact is illustrated in Chart No. 2. (Modified by Dr. L. R. Hafstad from an article by Sir C. F. Goodeve, *The Advancement of Science*, Vol. III, No. 12, Page 301.) Perhaps typical of many academic and non-academic institutes, Georgia Tech's investigatory work includes research typical of university research, *and* development work as indicated by the "Research Associations" curve. The Engineering Experiment Station also gets into the engineering phase to a minor degree. The "Research Association" curve best typifies the work of such institutes.

Many civilian scientists believe that an O.S.R.D. or N.D.R.C. (Office of Scientific Research and Development or National Defense Research Council) type of organization provides maximum utilization of *scientific* manpower. Considerable time is involved in staffing and implementing such organizations. The World War II

military establishments were organized on functional lines with emphasis on their particular requirements. This type of organization is best adapted to the engineering phase. Since World War II, the armed services have expanded greatly their own facilities and interests through contracts in the research phase and in the development phase.

Progress in research depends upon the skill and ideas of individuals. Only in applied research can any real benefit be obtained through group effort, with the groups consisting of scientists in the same field. Progress in engineering depends primarily on the extent of effort applied, with groups of engineers working in designated areas and cooperation between groups achieved through supervisory coordinators. Progress in development requires a high order of ingenuity and initiative of individuals *and* close cooperation of scientists and engineers working together. It is the need for such "development units" that has created the *research association* or the *engineering experiment station* type of organization.

The Problem

We have been told repeatedly that "next time there will be no time to organize for defense." In the event of such an abrupt, full-scale emergency, there would be no time for research-development-engineering, and our national effort would depend solely on what we have at the moment the emergency starts. However, a revision of national policy seems to be in the making: to maintain our world-wide responsibilities by a willingness to prosecute "limited war" if forced to, and not to wait for such an overbearing aggressive act that an all-out catastrophic war is our only recourse. If the future finds the United States in a "limited war" position, then great emphasis will be placed on development. The defense establishment *can* use practicable, if not perfected, means such as was done with the first airplane fire bombs, the interim tank-mounted flame thrower, and so on.

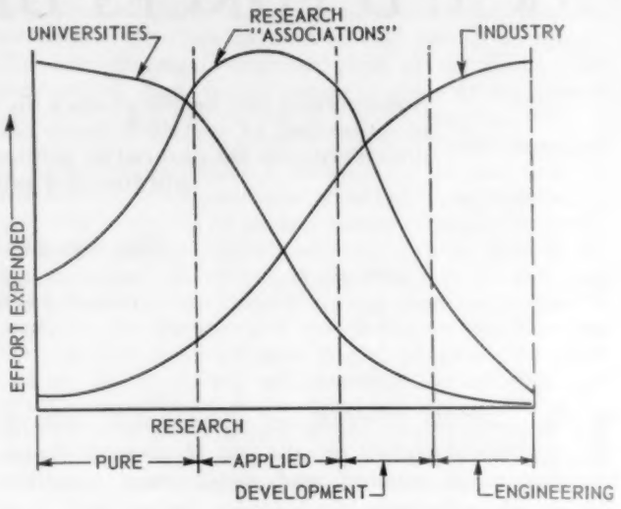
An inescapable conclusion is that development-type organizations, such as Tech's Engineering Experiment Station, should *not* be broken up by the sudden call-to-duty of its reserve officers and technicians to posts scattered all over the country. Rather, every effort should be made to keep these skilled teams together, to amplify their effort by additional skilled personnel already in the geographical area, and to insure that administrative procedures are adopted *in accordance with the objectives of development.*

It is remembered that in World War II practically all radar development was conducted in Laboratories at Harvard. We should not again permit such centralization of highly specialized personnel.

A Direct Approach

It is proposed that the Government establish "Armed Forces Development Units" at centers of developmental activities such as Georgia Tech and other association-type organizations. Here there exist functioning teams of scientists and engineers with immediately available consultants in many special fields, and a wealth of information in the libraries of adjacent universities and institutes.

CHART NO. 2. TYPE OF RESEARCH VS. TYPE OF FACILITY



In peace time, these units would function essentially as they are now, under the complete jurisdiction of the institute or association and with financial support largely from contracted projects. Planning for militarization in an emergency would result in a "paper" organization with definite assignments of personnel to key positions, and so on. In many places, new facilities are needed to better group Governmental research-development-engineering activities and in particular could be used to house the classified work being done for the Government. (Note that such construction would

CHEMICAL CORPS DEVISES MEANS FOR HCL DISPOSAL IN MAKING CHLORINE

Methods of disposal of hydrochloric acid generated at Army Chemical Corps chlorine plants which may save nearly $2 million in operating costs are described in a report just released for industry use through the Office of Technical Services, U.S. Department of Commerce.

The volume contains detailed operating instructions for methods of treatment of brine to remove contaminants prior to electrolysis. The procedures, which involve processing brine through Hooker cells to recover chlorine and caustic agents, were found both feasible and economic in tests at Rocky Mountain Arsenal.

The 172-page report, PB 151640 *Disposal Problems of Chlorine Plants: Final Report,* N. P. Cochran and J. W. Alker, Jr., Chemical Corps Engineering Command, U.S. Army, Aug. 1958, may be ordered from OTS, U.S. Department of Commerce, price $3.

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provide many jobs—a valid argument being employed to enlist support for a proposed large-scale postal-service building program, the highway system, etc.)

Such a unit also could be used for active duty training of military reserve technical personnel in the region. Mobilization assignments could be planned and made so that in an emergency the technical staff could be amplified overnight with trained personnel familiar with the personnel and operations of the unit to which they would report. For such planning and administration, a small staff of regular military personnel could be attached to the unit as liaison personnel thus relieving the technical staff of military administrative matters and, at the same time, assuring close coordination of the unit's activities with the interested and sponsoring military agencies. Project priorities could be planned, assigned, and placed "on-the-shelf" prior to emergency operations.

In the event of an emergency, the reserve officer scientist and engineer could immediately go on active duty, doing the work he is best qualified to do. The unit would be under a single commanding officer, military personnel would be paid by a single finance officer, etc. Civilian personnel could be given emergency Civil Service appointments and immediately assigned work for which they are best suited.

This, of course, presumes a true unification of the services—where one officer may exercise command over Army, Navy and Air Force personnel. This idea of an Armed Forces Development Unit is not brand new, but past objections known to the writer have almost all revolved around inter-service administrative difficulties! A February 11, 1958, syndicated newspaper article by Marquis Childs purported to reveal three principal points in a plan being developed by Presdent Eisenhower for reorganization of the Department of Defense. The second point listed in the article is vital to this AFDU proposal. This was that "units in a unified command are to be made organic units. The commander of a unit in which all three services may be serving would have full responsibility for promotions, demotions, trial by court martial and every other detail of service existence." It is inferred that an "organic unit" referred to large units such as task forces requiring combined land, sea, and air forces. There seemed to be no question as to the feasibility and the benefits gained from such organic units.

If unification would work for a large task force, it would certainly work for a small but vital task force: an Armed Forces Development Unit.

NEW CANISTERLESS MASK IS STANDARDIZED AS THE M-17

WASHINGTON, (ANS)—The canisterless mask developed by the Army Chemical Corps has been adopted by the Department of the Army, the Marine Corps, and the Navy Bureau of Docks as a standard item of issue.

Now officially designated the "M-17" in the Army supply system, the mask affords respiratory protection against chemical and biological agents and radiological particles. Soldiers state they prefer it to previous types because of its lower breathing resistance, superior vision, and better speech transmission. It eliminates the external canister common to the masks of all armies of the world through the use of a newly developed lightweight filter material. Pads of this pliable material are inclosed in cavities molded into the rubber facepiece of the mask.

All production is to be accomplished by industrial contractors, except for the filter material. Initial quantities of this material will be produced by the Chemical Corps in order to facilitate proper quality control.

The new item marks the first significant change in mask evolution since 1947, when the M-9 series (characterized by its canister projecting from one of the facepiece cheeks) was adopted. Current stocks of the previous types will be gradually replaced as they are depleted in troop use; replacement will be made on a one-for-one basis. The new item will considerably simplify supply and stock problems, since it will not require the M-9's full assortment of sizes in both left-and-right handed facepieces for the projecting canister.

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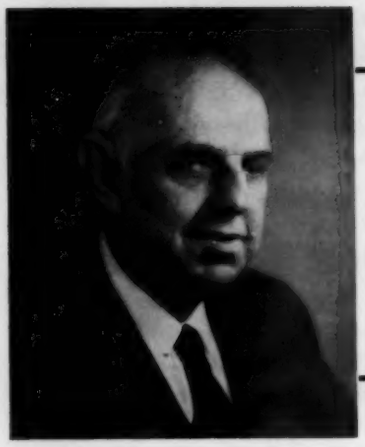

DEFENSE CHEMISTRY IN THE NEWS

By WILLIAM T. READ, SR.

This Department consists of condensations of news releases and of articles in technical journals relating to developments in chemistry, chemical engineering, and kindred subjects, which are of definite or probable military interest. Unless specifically so stated in the text, the information presented is not to be construed as based upon original or official sources.

BASIC RESEARCH

The researches of Wright Air Development Center on perarylated silanes, announced in the Nov.-Dec. 1958 issue of THE JOURNAL, have been considerably expanded, and numerous avenues of development have been suggested by this work. In addition to the parent member of the perarylated silanes, $(C_6H_5)_4$ Si, mixed phenyl, p-biphenylyl monosilanes have been prepared, which have the general formula, $(C_6H_5\text{-}C_6H_4)_nSi(C_6H_5)_{4-n}$, n being equal to 1,2,3,or 4. Still another type is that of phenyl, 2-thienyl silanes, in which a five-member ring containing sulfur replaces one or more phenyl groups. More complex silylarylenes having more than one atom of silicon per molecule are being studied. An infinitely large number of these compounds appears to be possible. The major factors in the choice of these substances are high thermal and radiation resistance. Efforts are also being made to lower melting points by mixtures or by introduction of alkyl and other groups, even at the risk of somewhat lower thermal stability. This is to make such materials available as lubricants.

A new method of studying high-temperature reactions has been developed as a by-product of investigations of the effects of sunlight on the aging of polyethylene plastics. A specimen of this polymer was exposed to the flash from a heavy-duty spiral filament lamp, whose single 3 millisecond discharge of 5000 joules produced black, fluorescent spots and microbubbles in the transparent specimen. This effect was found to have been caused by trapped particles in the clear medium. The technique of the present process involves exposure of finely divided absorbing materials in a transparent medium and exposure to a high intensity, high speed flash. The time involved is so short that side reactions do not occur. The transparent insulating matrix may be solid, liquid, or gas, while the material to be examined is light-absorbing. Many problems may be solved by this method. A few that have been suggested are: the structure of coal; prolonging the life of a missile nose cone; and protective clothing against nuclear blasts. Still higher temperatures and shorter flash times appear quite possible.

NUCLEAR MATERIALS

Rare earth elements are not scarce, nor are their ores expensive. Their high cost lies in the great difficulty of separation, so that an element of high purity can be obtained. Yttrium, a relatively abundant element, costs as much as $60 a pound, and other elements may cost up to $2000 a pound. Most of the rare earth elements that are marketed today go into the atomic energy industry. Yttrium has a low thermal neutron cross section, and others such as samarium, gadolinum, europium, and dysprosium have high cross sections and are used in control rods and neutron shields. The only method of separating these elements on a large scale is by the use of ion exchange columns. Three years ago, in response to a demand of the Atomic Energy Commission, a plant was built in four months to provide quantities of yttrium oxide. The story of the plant has just been made public, with the lifting of restrictions on this type of information. Batteries of 20-foot ion exchange columns are required. These are glass-lined and are filled with a high-capacity cationic exchange resin of the sulfonated styrene-divinylbenzene copolymer type. Concentrated minerals are dissolved in acid, and a band of rare earth compounds is adsorbed on the resins of one column. The band is then expanded into three other columns. The eluting agent is ethylenediaminetetracetic acid, commonly known as EDTA. The more stable of the earth-EDTA complexes move forward in the column. Batches are collected at the foot of the fourth column in each battery, and are analyzed. In some cases reruns are necessary. Oxalic acid precipitates the purified elements, and rare earth oxides are obtained by calcination of the precipitates. One band requires four months to push through a large column. Other users are coming into the picture, such as the electronics, ceramics, and metallurgical industries. A half-century ago, the only known use of ion-exchange materials was in the softening of water.

A new fuel fabrication plant has as its purpose ways in which plutonium fuel elements may be made for use in power reactors. Uranium-235 is now in very general use, but it is present only to the extent of 0.7% in natural uranium. Plutonium-239 can be made from uranium-238, and the excess neutrons produced in a fast reactor using this element will make more plutonium from the uranium-238 blanket with which it is surrounded. The production of plutonium as a reactor fuel presents many difficult problems. In addition to numerous crystal forms, solid state transformations, and volume changes, its intensive emission of alpha particles is extremely damaging to biological tissues. It has

been pointed out that plutonium gives off 5 million times as many alpha particles as do either uranium-238 or thorium. In the new plant, helium is used as the process atmosphere, and all work is done in hoods with glove boxes, and mainly by remote control.

A promising method of disposal of radioactive wastes containing such fission products as strontium-90 and cesium-137, now under development in Canada, depends on incorporating them into a glass. Lime and a complex silicate fuse together to form this glass. If a concentrated nitric acid solution of the radioactive waste elements is added hot to a mixture of lime and the syenite, the latter being the main component, a gelled slurry is formed. This forms a firm gel which becomes rigid after water and nitric acid are driven off at temperatures up to 150°C. The gel is sufficiently porous to permit the escape of gases. Denitration is completed by the time a value of 900°C is reached. The gel is melted at 1350°C, and the melt is cooled slowly to prevent cracking. The gases from the process are freed from any radioactive materials by absorbers, scrubbers, and filters. Maximum leaching with water is said to remove about one millionth of the weight of the glass in a year. Other work is being done in the United States to incorporate liquid wastes into a gel with sodium silicate, and to lock in radioactivity by adsorption on clay and subsequent calcination.

ROCKET FUELS

The active alkali metals, rubidium and cesium, are being produced in pound lots as commercial chemicals with no immediate industrial uses in sight. However, the ease of ionization of cesium points to its application as a plasma for ion propulsion motors in the field of space travel. Rubidium has possibilities as a heat transfer fluid in nuclear rockets. The amount of cesium now available is greater than all of this metal that has been consumed since its discovery. Lepidolite ore is the source of a mixed potassium, cesium, rubidium carbonate, which is sold to the glass industry on the basis of its equivalent potassium content. This material contains about 21% rubidium carbonate and around 25 cesium carbonate. Complex salt formation is said to be the basis of the separation of the three elements, while the metals themselves can be obtained by thermal reduction of their melts by magnesium.

Liquid hydrogen, the rocket fuel with the highest thrust with liquid oxygen, has been consistently tagged with the term, "hard to handle". However, two plants providing this fuel for development and testing are now supplemented by a new plant in Florida which produces what are referred to as "large tonnages" of liquid hydrogen for the Air Force. Announcement has been made by the National Aeronautics and Space Administration of the letting of a contract for a hydrogen plant that is still larger than the one referred to above. Hydrogen is made in the Florida plant by partial oxidation of heavy fuel oil. Oxidation is accomplished by oxygen derived from liquid air by fractional distillation. The nitrogen from this process is employed in processing liquid hydrogen. Expansion and liquefaction of hydrogen is accomplished in turboexpanders. Conversion of the undesirable orthohydrogen to parahydrogen is brought about in the presence of hydrous ferric oxide as a catalyst while the hydrogen is in the liquefier. The product of the plant just described is said to be the purest liquid hydrogen ever made.

Aluminum is being used as one of the fuels in missiles with marked increase in boost velocity over those which do not contain aluminum powder. This metal is also being used in high performance meteorological research rockets. Potential increases in range or altitude are estimated as being of the order of 20% for intermediate and intercontinental missiles, and as much as 60% for air-to-air missiles. The probability of chemical reactions that would spoil a propellant or cause fires in the plant in which it is being manufactured is greatly lessened by employing microscopic spheres of plastic, a plasticizer oil in which the particles are suspended, and the propellant oxidizer. The raw propellant mix with the consistency of a soft dough is converted to a propellant by heating to around 350°F. The plasticizer oil fuses with the plastic spheres very rapidly to form a tough, uniform plastic mass in which the oxidizer is imbedded. The propellant is then cooled, trimmed, and loaded into the rocket shell. The standard processing method is a casting process, but extrusion methods show considerable promise. The outside of an internal-burning grain is coated with inhibitor plastic mix which contains no oxidizer. Burning rates are modified by additives, and temperatures at which motors are fired by plastic binder ingredients. A polyvinyl chloride-ammonium chlorate formula containing high-energy jet materials such as aluminum have a theoretical flame temperature of around 5600°F, but other formulations may have values as low as 2000°F.

METALS

Vacuum deposition of aluminum in relatively thick films on steel appears to have considerable value in the aircraft and related industries. Such films are nonporous, ductile, and tightly adherent, and may be anodized to give greater abrasion resistance. No cracking or lifting has been observed with 0.0015 inch aluminum coating on sheet steel after 180° bending, and no loss in yield strength takes place with vacuum-coated steel.

By use of new raw materials, tough coatings of chromium, tungsten, and molybdenum are being applied by a vapor phase deposition method on less corrosion-resistant metals and on nonmetals such as graphite. The basis of the process, chemical reaction of a volatile compound of the protective element at the heated surface of the metal or nonmetal being coated, is old, but materials and special techniques are new. The compound is carried by an inert gas such as helium or argon to a deposition chamber in which the part to be coated is held. The exit gases are taken off through a filter trap.

Deposition of an extremely thin layer of a material under extremely low pressures was developed during World War II in order to coat lenses with antireflecting transparent salts. This technique is now being studied in connection with deposition of metals on tiny electronic components. It is also being used with semiconductor material for transistors, diodes, wave guides, printed circuit work, xerographic plates, and rectifiers. Paper may be coated with aluminum to act as a thermal barrier for use in building insulation. A further application is that of heat-reflective coatings ranging all the way from skylights to missiles. An early commercial use of vacuum metallizing was that of a "second surface" on transparent materials, the coating being applied to the back of plastic articles, followed by a protective and retaining paint. Metal layers of only a few millionths of an inch in thickness are now being applied to the outer surface of plastics, with a protective coating of a transparent lacquer. An immediate application is to interior surfaces of passenger cars. A thick film process is being developed which will permit finishing of exterior metal surfaces. Vapors from a metal heated in a high vacuum condense on a cold surface,

forming a mechanical bond. Improved high-vacuum pumps and mechanically refrigerated cold traps are largely responsible for the success of these modern vacuum metallizing processes.

A titanium alloy containing copper, aluminum, and zirconium has been developed by the Air Force as the result of a study of the active eutectic titanium alloy system in which the decomposition of the beta phase to alpha-plus-compound occurs very rapidly. This alloy has a tensile strength of a little under 109,000 psi at 1200°F. In the annealed condition this alloy shows a tensile strength of 165,000 psi, and the drop-off in this property is largely above the 1000°F point. A heat-treatable titanium sheet alloy containing aluminum, molybdenum, and a small amount of beryllium has essentially the same strength at room temperature as the first alloy described. Even though not more than 0.25% of beryllium is present, this element is credited with being the most successful precipitation-hardener so far used in titanium alloys.

GLASS AND CERAMICS

Low-melting glasses show promise as coatings of semiconducting devices sensitive to moisture. Sulfur and selenium are the major components of such glasses, together with arsenic and thallium. The fluid range is reported as being between 125°C and 350°C. Coating can be accomplished either by dipping or by evaporation and condensation as thin films. The selenium glasses bond well to ceramics and silicate glasses. Chemical durability is of the same order as that of ordinary glasses, the main exception being attack by concentrated alkaline solution. Some are stable to air oxidation above 250°C. They are also extremely impermeable to water and helium, and have good wetting properties.

Photosensitive glasses were announced a decade ago, and researches in this field have led to a new field of glass technology now known as "glass-ceramics". Announcements of this type of silicate materials were made two years ago. A complete discussion of the principles and processes of conversion of glass to fine-grained crystalline material has just been published. The new glass-ceramic material depends on rigid control of the size and properties of the crystals developed. This is accomplished by the use of catalysts which furnish submicroscopic crystals. The homogeneous catalyst crystals become the nuclei for another heterogeneous crystal phase made up of the major components of the material. Catalyst crystals are precipitated to the extent of 10^9 to 10^{15} per cubic millimeter of glass. When crystallization is complete the size of the homogeneous crystals ranges from 1 micron to 100 A. Further heat treatment may produce recrystallization and intergrowth of small crystals.

The new glass-ceramic materials have higher tensile strength than ordinary clay products, and greater hardness and scratch-resistance than either glass or ceramics. Thermal expansion coefficients vary with chemical composition, and those with values close to zero are practically immune to thermal shock. Chemical resistances are comparable to those of chemical glasses. Most glass-ceramic materials are electrical insulators.

There are numerous nucleating agents, the most common being titanium dioxide. Lithia-alumina-silica compositions find use in kitchen appliances, cooking dishes, tubing, pipe, and bearing and races for high-temperature service. Magnesia-alumina-silica compositions are adapted to electrical insulation and guided-missile radomes.

Reports recently released by the Air Force deal with a high-temperature refractory, metal-ceramic laminates, and ceramics reinforced by metal fibers. Zirconium oxide, generally known as zirconia, has a melting point at 4850°F, excellent strength properties, and therefore great potential for high temperature use. The usefulness of this material depends on control of its crystallographic transformation. In the same report, a new class of materials, prepared by addition of small amounts of refractory metals to oxides is described, these being referred to as "meta-modified" oxides. When the thermal expansion of a ceramic material is equal to or slightly less than that of a metal, metal-ceramic laminates may be made by brazing or by hot-pressing. Typical products of the first technique are Fosterite-stainless steel and molybdenum-alumina, while hot-pressing is employed with molybdenum and an alumina-mullite ceramic. Molybdenum fibers are incorporated into alumina, and the product sintered with additional alumina to form products of high thermal shock resistance. Products made of alumina alone appear to be superior in strength and impact resistance. Microcracks develop unless the percentage of metal fibers is kept fairly low.

Two dielectric materials, magnesium oxide and aluminum oxide, have been found by Air Force contractors to have insulation resistances high enough for use in capacitators operating at 500°F under nuclear radiation. Boron nitride is useful when there is no radiation. These materials meet the very difficult requirements of resistance capacitance greater than five megohm-microfarads at 500°C, provided that they are extremely pure. Fabrication methods include slurry dipping, fusion to platinum electrodes, electrolytic deposition of the oxides, and assembly of coldpressed disks and electrodes.

PETROLEUM PRODUCTS

Researches by the U.S. Bureau of Mines indicate that nonionic detergents of the ethylene oxide-propylene oxide type are much less easily adsorbed in the water-flooding of oil fields to recover oil from sand and rock surfaces than are other types of detergents. This indicates that this method of recovery of otherwise lost oil resources may be more economical than has previously been thought. Compared with other nonionic detergents, a molecule of the type covered by this investigation takes up an area of 2880 square Angstroms against from 35 to 200 of the others. The hydrophobic groups in the molecule are relatively large and centrally located, rather than being small and at the end of the molecule.

Hydrocarbons containing five and six carbon atoms constitute from 15% to 20% of the gasoline made in a typical refinery, and these have the lowest octane value. This figure may be improved by aromatization, by dehydrogenation to olefins, and by isomerization. The first two are less selective reactions and give lower yields, and also olefins have poor lead susceptibility and low octane ratings. The raw material is largely straight-chain paraffin hydrocarbons, while the most highly branched isomers are the highest in octane ratings. Thermodynamic equilibrium is most favorable to forming branched chains at relatively low temperatures. Former processes based on isomerization either operate at the upper limit of isomerization with a precious metal catalyst or at 200°F to 250°F with a sludge of aluminum chloride as a catalyst in liquid hydrocarbons. A new method which gives yields of nearly 100% of the desired branched-chain hydrocarbons employs a catalyst with a Friedel-Craft component and operates at

80°F to 120°F. The "blending octane value" of the product as it is mixed with other motor fuels is higher than its 98 Research octane value. The material is expected to extend the supply of aviation gasoline as well as that of premium motor fuels.

Tetraethyl lead continues to be the leading antiknock compound for internal combustion engines. New processes, however, are being developed to lower costs and to improve efficiency in production. A method now in pilot-plant stage gives high yields and operates with low loss of lead. It is based on the production of sodium hydride, which reacts with an aluminum alkyl and ethylene to form a complex containing sodium, the ethyl radical, and the alkyls originally associated with aluminum. An electrolytic cell with a lead anode produces tetraethyl lead, sodium, and the regenerated aluminum trialkyl. The reaction takes place at 100°C as compared with the present process which requires a temperature of several times that figure for electrolysis. Other processes under development include reaction of triethyl aluminum with lead oxide; complex metal alkyls with metallic lead or its salts; and direct ethylation of metallic lead with very little lead being recycled.

The rapidly increasing consumption of light grades of petroleum fuels such as kerosene by jet aircraft is requiring the designers of diesel engines to produce engines that will operate satisfactorily on what are known as "residual fuels". Many marine and stationary diesel engines are now operating on such fuels, and work is being done to make locomotive diesel engines that will run on these fuels. Processes involving heating and centrifuging the fuel, and modifications of injecting equipment are both contributing to the solution of the problems presented by a scarcity of lighter petroleum products.

HIGH POLYMERS-PLASTICS

At a conference sponsored by Wright Air Development Center the various approaches to the goal of polymers and fluids usable up to 1000°F were discussed. So far such materials have not been made on anything more than an experimental basis. The field, however, has only been extensively investigated for not more than five years. It was pointed out at this conference that knowledge of inorganic polymers is now about where organic polymer development was forty years ago. The two major approaches appear to be inorganic or semi-inorganic derivatives. Polymers with an aluminum-oxygen backbone with aromatic substituents, some of which contain silicon, give some promise. Phosphorus and boron are other elements which may enter into the semi-inorganic field. A variety of silanes and siloxanes together with siloxanylferrocenes are being extensively investigated.

Measurements of the apparent viscosity of polymer melts have been made which are independent of the driving force of hydrostatic pressure, and these have led to the conclusion that great increases of injection molding pressures may cause such a large increase of viscosity that the net increase in flow rate is not enough to justify the expense of achieving the higher pressures. For example, a 14-fold increase of viscosity of polyethylene was caused by 24,000 psi hydrostatic pressure, and the increase in the cause of polystyrene melts at only 18,000 psi was 135-fold.

A plastic barge, made of woven nylon coated inside with acrylonitrile-butadiene rubber and outside with neoprene, has made a successful deep-sea voyage of 500 miles, hauling 40 tons of liquid hydrocarbons. Waves of nine feet in height in the North Sea caused no trouble, the barge riding over and through their crests. This method of water transportation is applicable to many lighter-than-water liquids, and the cost of such barges is about one fifth that of steel tankers. Towing in this case was done by an ocean-going tug.

Irregularly shaped items can be satisfactorily stored for long periods indoors in strippable plastic containers in which a low humidity can be maintained. Such containers have several advantages over dehumidified warehouse storage in cost of fabrication and maintenance and the mobility of stored wheeled items. They are also light in weight and are easily removed. If employed out of doors, storage is limited to two years unless topcoatings are applied of mastic or of mastic and aluminized paint.

HIGH POLYMERS-RUBBER

Modification of natural rubber by organic thiol acids has been shown by an Ordnance Corps investigation to reduce the tendency of this material to crystallize. Anticrystallizing rubber and unmodified rubber have the same low temperature properties, except that the modified material is superior in elastic recovery. The modified rubber, however, has poorer retention of strength-strain properties after oven aging. Brittleness tests for elastomeric vulcanizates depend for accuracy and reproducibility largely on impact speed. A method has been developed to measure the striker speed of a commercial solenoid tester, and changes in requirements are expected to follow this investigation.

A method of grafting polymers by an anionic catalyst directly on a roll mill was reported by Army Ordnance at the recent Army Science Conference. The catalyst is a sodium alcoholate which is formed as a milled sodium dispersion in a material like polybutadiene, and is worked on mill rolls with styrene. The alcohol is added, cooling is stopped, and polymerization starts. The original dispersion of sodium is carried on at 60°C, but the mill rolls are cooled to 20°C when the second raw material is being incorporated. Styrene has been grafted by this method onto both polybutadiene and a copolymer of butadiene and acrylonitrile. Stabilizers do not prevent this type of grafting, so that polymers can be stored until grafting begins. Any type of mill may be used, and a nitrogen atmosphere is not needed.

A rubber-asbestos insulation for soild-fuel rocket motors has been developed for the Navy Bureau of Ordnance. This material is expected to extend the burn-

(Continued on page 30)

Palladium Ammonium Chloride, Palladium Black
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Pentaacetyl-d-gluconononitrile, [illegible]
[illegible] Pent
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TO BURN JAPAN WITH THE HELP OF A BAT

By WYNDHAM MILES, Ph.D.
U.S. Army Chemical Corps Historical Office

THE IDEA of employing animals to carry incendiaries is as old as the Bible and as modern as World War II.

And Samson went and caught three hundred foxes, and took firebrands, and turned tail to tail, and put a firebrand in the midst between two tails. And when he had set the brands on fire, he let them go into the standing corn of the Philistines, and burnt up both the shocks, and also the standing corn, with the vineyards and olives.

—Judges, 15:4–5

Medieval man used rats, cats, dogs, and pigeons to carry incendiaries. To these creatures he fastened little sacks filled with slow burning powder, and then released them toward his enemy. But while he was a cut above Samson technologically, he was not always as lucky. At the siege of the Hussites in Saaz in 1422, birds released by the besiegers turned and set fire to the camp, burning it so completely that the siege had to be raised.

Manuscripts on pyrotechnics dating from the 15th and 16th centuries occasionally give directions for preparing animal incendiaries. An illustration from a German manuscript *Feuerwerkbuch*, written in 1584, is shown here. Powder for cat incendiary was a mixture of saltpetre, sulfur, and charcoal. The powder was moistened with wine or vinegar and poured in a small sack also wetted with wine or vinegar. The sack was closed and set in the sun to dry. The sack was tied to the back of a cat belonging to the beleaguered city, a hole was made in the top of the sack, a match was placed to hole, and the cat was released. Off flew the cat to hide, it was hoped, in the barn, or the hay, or some other flammable place. Incendiaries for pigeons were made in much the same way. It was particularly important to capture city pigeons, not their country cousins.

With the passing of centuries and the creation of modern weapons we might expect that animal incendiaries would be as dead as the Dodo. But not so. On December 7, 1941 a surgeon from Pennsylvania, was driving from Carlsbad Caverns, New Mexico, when he heard news of the Japanese attack over his car radio. The thought flashed through his mind that the millions of bats in American caves might be fitted with incendiary bombs and dropped on Japan. He drove back to Carlsbad, captured some bats for tests, ransacked libraries for data on bats, and in January sent his proposal to the White House, whence it was referred to the War Department. The surgeon and his search team drove many thousands of miles, traveling day and night, to explore bat caves. In their year-long survey they found America's largest colony, estimated at between 20 and 30 million bats, in Ney Cave, Texas.

In the meantime scientists from MIT, UCLA, Harvard, and other universities were working on other phases of the project. They found how much weight bats of different species could carry, and how bats could be cooled and thus forced into hibernation for storage, handling, and so they would stop eating (a bat can eat up to twelve times its weight of insects each day).

The Chemical Corps was called into the project early in 1943. Professor Louis F. Fieser of Harvard, and Captain Wiley W. Carr, then of Chemical Warfare Service devised two different delayed-action incendiary bombs weighing less than an ounce. Bombs were attached to skin on a bat's chest by a surgical clip and a piece of string. The Army Air Force ran tests at Carlsbad. A dummy village in the desert was burned to the ground. Then some bats got loose and burned a general's automobile and a two-million dollar hangar. The Army gave up the project.

The Navy took it over and continued the tests. Bats were packed like eggs in a crate, and dropped by planes. The crates opened at a certain altitude and the bats tumbled out. They were supposed to awaken in the warm lower air and glide away, but most of them slept on. Those that woke flew to hiding places, as they were supposed to do, chewed through the strings and moved along, leaving the bombs behind.

All of this experimentation took time. Full-scale tests could not be scheduled before August 1944. When the

TO FIRE A CASTLE WITH THE HELP OF A CAT—From a manuscript on pyrotechnics, dated 1584, in the Smith Collection, University of Pennsylvania. The original is in vivid colors. Notice the incendiaries fastened to the pigeon and the cat.

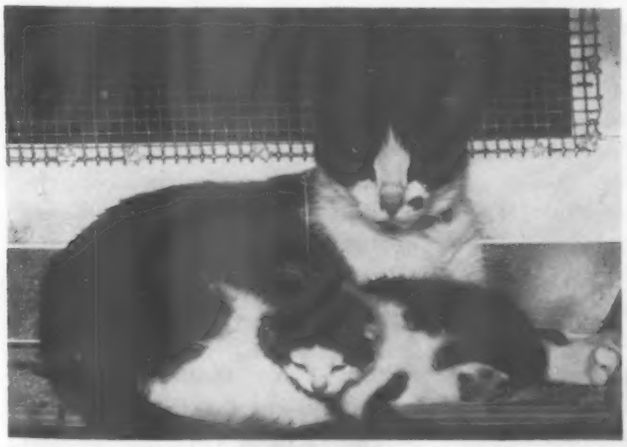
BAT BOMB AND HOW IT WORKED

Bomb attached to a bat by a surgical clip and piece of string. Upon landing the bat chewed through the string, crawled away, left bomb behind. Bomb was armed before being attached to bat by an injection of copper chloride solution, which slowly corroded a steel wire holding the firing pin.

Chief of Naval Operations learned that combat bats would not be ready until mid-1945, he cancelled the project.

So ended one of the most extraordinary projects of World War II. One can not help wondering what might have happened if bomber bats had invaded Japan. Because now, in an age of rockets, intercontinental ballistic missiles, and atom bombs, it looks as though animal incendiaries have returned forever to the past ages.

"SPEEDY," FAMOUS CHEMICAL CORPS TEST CAT, SERENE IN MOTHERHOOD



Speedy, the Chemical Corps' "Fear Gas" Cat and her first-born Kitten.

EDGEWOOD, MD.—Speedy, the Army Chemical Corps' famous 'fraidy cat, like many another film star before her, has retired from the public eye in favor of a life of placid domesticity.

She's currently busy mothering her healthy first-born kitten, "Chemmy" (for Chemistry Corps), a furry, black-and-white carbon copy of her matinee-idol mother.

Speedy was the talk of the nation last December when the Army released films which showed her recoiling in terror before the onslaught of a tiny white mouse, after she had been subjected to a new psycho-chemical "fear" gas.

The Chemical Corps films were carried in the newsreels and on the network television news programs, and the nation's front pages featured pictures and detailed accounts of Speedy's astoundingly unfeline behavior.

Scientists of the Chemical Warfare Laboratories here, who have kept Speedy under close observation since her retirement from experimental work, say she's as good as new, and completely restored to her former prowess as a mouser.

NEW NAME FOR UNIT

FORT McCLELLAN, ALABAMA.—The name of the First Radiological Safety Support Unit, commonly known as "Rad-safe" and "1st RSSU" since it was established at Fort McClellan in 1953, is now the U. S. Army Chemical Corps Radiological Unit. The mission and functions of the Unit remain essentially the same.

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SPACE VEHICLES

(*Continued from page* 12)

a material which has not yet fulfilled early expectations, but which is still a strong contender in the class of light-weight, moderate temperature structural materials. Sheet alloys of titanium are suitable up to 600°F, and newer alloys show promise up to 1200°F.

The most widely used materials for rolled sheet products are high-strength steels, some of which have tensile strengths of 150,000 psi at 1000°F. Stainless steels have good corrosion and oxidation resistance, and some very-high-strength steels are employed for short times up to 1200°F.

Beryllium has excellent thermal properties, which would recommend it as a heat-sink material in missile systems. Its density is 1.8; it has a high modulus of elasticity; and its melting point is 2343°F. As a structural material it is currently handicapped by low ductility and by brittleness.

b) In the second group, used between 1200°F and 1800°F, are what we know as "super alloys", based on nickel, cobalt and iron. These are the major heat-resistant materials in gas turbines. Nickel base alloys can operate under high stress conditions at 1800° F. In addition to castings and forgings, the super alloys are finding applications in the sheet metal field.

c) For ultra high temperature service operations, newer alloys are based on the refractory metals, of which molybdenum is the most important. Tungsten has a melting point of 3410°C as compared with 2625°C for molybdenum, but tungsten alloy developments have not reached the same stage of advancement as the molybdenum alloys. Other refractory metals are niobium (still very commonly known as columbium), tantalum, some platinum metals, and the very scarce element, rhenium. Lack of oxidation resistance is a major drawback of most refractory metal alloys, but this defect may be overcome in part by coatings, and to some extent by new alloying techniques. An interesting forward step in the hot-working of molybdenum and other refractory metal alloys is the carrying out of these operations in an atmosphere or argon. An entire room is filled with the inert gas, with operators wearing space suits fed by conditioned air, and with exhaled air being removed by a second line.

In this category of materials for ultra high temperature use are cermets and ceramics. Such compositions as cemented titanium carbide with binders of nickel-base alloy, and chromium-molybdenum alumina have been considered for use in small gas turbine wheels. Cermets and ceramics show most promise in rocket nozzles and guidance components. Coated graphite is potentially useful at temperatures above 4500°F, and, for short-time applications, unprotected graphite performs satisfactorily.

Another way in which materials may be employed which have reached their limits of use in spite of their high melting points is that of thermal protection or heat-alleviation systems. These all function to prevent heat from penetrating to the primary structure, and include ablation and sublimation coatings, transpiration, film or liquid metal cooling, heat sinks, and insulating layers. Even plastics, reinforced with glass fiber or asbestos, are employed in nozzle throats, the surface carbonizing to form a protective layer which gradually erodes.

Composite materials and structures are being developed to meet operational requirements. These involve pure metals containing finely dispersed oxide particles, ceramics containing metal fibers and meshes, metals with glass-fiber reinforcing and complex multilayer configurations.

Rocket and Missile Propellants

Leaving out fuels for air-breathing propulsion systems, which, however, include some high-energy chemicals, attention is now directed to oxidants and fuels for rockets and missiles. Propellants may be broadly divided into the solid and liquid types. The energy-producing capacity of either type is expressed by the term "specific impulse". This is defined as the thrust in pounds developed by the action of one pound per second of propellants. It depends on many factors-the average ratio of specific heats, exit pressure, chamber pressure, average molecular weight of combustion products, and combustion chamber temperature. The specific impulses of propellants range from 180 to over 370 lb. sec/lb., depending on the type and nature of oxidant and fuel.

Solid Propellants. The earliest rocket propellants were of the same type as those used in trench mortars. Modern long range rockets must have larger grains, which are commonly cast in the form of a cylinder filling the entire metal chamber of the rocket. The outer surface is coated with a material composed of the fuel binder and an inert filler, which causes the grain to burn from the walls of the central perforation towards the outside. The symmetrical series of perforations characterizing gun propellants is replaced by a single perforation whose sectional cross sectional area is larger than that of the throat of the rocket. It is also of such design that the burning area will remain as nearly constant as possible during the entire operation. A typical perforation is of circular cross section with radiating deep grooves extending well towards the outer wall of the grain.

As much as 75% of the weight of the propellant is the oxidant. The most common oxidants are ammonium nitrate, and potassium and ammonium perchlorates. Lithium perchlorate is also entering the field. Fuels are high polymers having the necessary flexibility, elasticity, tensile strength, and temperature stability. They are usually of the polysulfide, polyvinyl, and polyurethane types, and are often referred to as rubber. Some additives are employed, such as aluminum and magnesium powders, and may include chemicals containing fluorine.

Solid propellants have so far been confined to smaller missiles, but the size of vehicle in which they may be used is being rapidly extended, particularly to those missiles fired from mobile bases such as submarines. Even a solid fuel ICBM missile is being developed.

Liquid Propellants. Liquid fuels and oxidants are stored in separate compartments in a missile, and are mixed as they burn by being forced through holes in an injector plate. In smaller motors the liquids are driven into the combustion chamber by an inert gas such as helium, but the larger motors are equipped with high-speed rotary pumps. Unless the fuel-oxidizer system is of the hypergolic type in which combustion is spontaneous on mixing, a glow plug is required to start combustion. One of the liquids flows through the jacket of the combustion chamber as a coolant, the rate of flow being sufficiently rapid so that the liquid remains below its vaporization temperature. Flame temperatures must be as high as possible consistent with structure limitations, while dissociation of reaction products tends to use up the energy of combustion of fuels. The molecular weight of combustion products must be kept low, this commonly being around 20. With the fluorine-hydrogen system, this value is less than 9, hydrogen being in excess.

The highest specific impulses are achieved only with low-boiling liquid propellants such as liquid hydrogen-liquid fluorine (specific impulses about 370 seconds). For "storable" liquid systems, which can be stored at essentially ambient temperatures and pressures, specific impulses are much lower (e.g. red fuming nitric acid-aniline, specific impulse about 235 seconds). The specific impulses for storable liquid systems and the best solid systems are comparable.

The earliest oxidizer employed in liquid propellant was hydrogen peroxide. It also may be used alone as a propellant of low performance, decomposing into oxygen and water. It might also be a source of water and oxygen for crews of rocket ships. The most commonly used oxidizer in satellites and long range military propulsion systems is liquid oxygen. Its boiling point is -360°F, and it can not be stored in the rocket for any length of time. Red fuming nitric acid (22.5% NO_2) has a lower specific impulse with fuels to which it is adapted, but it can be stored for longer periods. The most efficient oxidizer from the standpoint of specific impulse is liquid fluorine. It is also hard to store, its boiling point being -367°F. It is also hard to handle, and, when used with hydrogen or hydrogen-containing fuels, the combustion products consist largely of highly corrosive hydrogen fluoride. Nitrogen tetroxide, N_2O_4, is now being investigated as an oxidizer. It boils at 70°F, and has a liquid range of 50°F.

The most common liquid fuel is a petroleum distillate of the kerosine type, which is referred to as JP-4 gasoline. With liquid oxygen its specific impulse is 264, but with liquid fluorine the value rises to 280. Aniline appears to be employed only with red fuming nitric acid, and other nitrogen compounds using the same oxidizer are ammonia and unsymmetrical dimethyl hydrazine. Hydrazine is used with hydrogen peroxide, liquid oxygen, and liquid fluorine. It is unstable and toxic, but is more reactive than gasoline. Of all the liquid fuels, hydrogen has the highest specific impulse, but has the drawback of being extremely hard to handle, requiring cryogenic temperatures to retain it as a liquid, or around 20.4°K.

Other propellant systems that are being studied, but which appear to be feasible only in the far distant future, if at all, include these three:

A rocket with a nuclear pile as a heat source, and hydrogen or helium as the working fluid.

Free radicals combined in a rocket motor, these having been previously produced, and stored at extremely low temperatures.

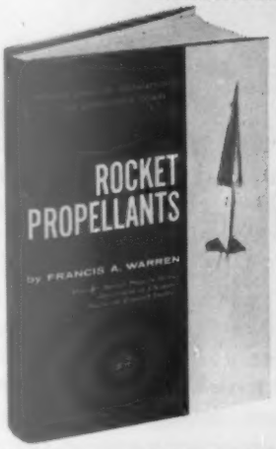
Ion propulsion with easily ionized metals accelerated in a magnetic or electrical field.

Includes chemical, manufacturing and performance details...

ROCKET PROPELLANTS

by FRANCIS A. WARREN

Manager, Special Projects Section, Department of Chemistry, Southwest Research Institute



1958, 228 pages, $6.50

The purpose of this book is to provide technical men with basic information on the materials being used to propel the rockets and missiles of today, and to recount in an objective manner the fascinating story of rocket fuel development.

It contains the composition, manufacturing methods, and performance details of both solid- and liquid-propellants used in rockets, from small signal units to the largest missiles currently being launched. The book also includes chapters on propellant burning, ignition and igniters, and the various rockets that use each kind of fuel. There is comprehensive information on safety in the propellant manufacturing plant, and quality control of the product.

A final section looks to the future of the present fuels, and reviews the theories that may lead to new ones, such as ion and photon propulsion, and antigravity.

CONTENTS: Propellant Systems; Propellant Ingredients; Solid-Propellant Manufacture and Processing; General Performance Characteristics; The Burning of Propellants; Ignition and Igniters; Solid-Propellant Rockets; Liquid-Propellant Rockets; Safety; Evaluation and Quality Control; The Future of Propellants.

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1959 MEETING OF THE ASSOCIATION OF THE UNITED STATES ARMY

General Lyman L. Lemnitzer, the new Chief of Staff of the Army who took office July 1, made his first major speech since assuming his new office, in addressing the opening session of the Association of the United States Army, which held its 1959 Annual Meeting at the Sheraton-Park Hotel, Washington, D.C., August 3-4 and 5.

General Lemnitzer's topic-"Why We Need a Modern Army"-keynoted the meeting's 3-day program, which emphasized the conception of a "Modern Army" as one equipped and trained not only for all-out use of nuclear weapons but also for "limited warfare" requiring the most up-to-date armament and equipment of conventional types, a contingency which some consider more likely.

In that connection General Lemnitzer stated it may be anticipated that in not too many years our retaliatory capability for use of intercontinental ballistic missile systems will have become so great, because of numerous resources and development of means of protecting ICBM missiles systems against attack upon them, "our response to the attacker would be absolutely devastating to him, so clearly so that it would be senseless for him to attack in the first place." "When that time arrives", General Lemnitzer continued, "it would bring about what has been called the equivalent of strategic nuclear disarmament." This, he said, would mean that the other components of our power would play a vital role in coping with enemy tactics and strategy short of the threat of general nuclear war.

The estimated meeting attendance was some 3,000 or more, but, despite this capacity audience, General Lemnitzer and other speakers emphasized need for increasing membership in the Association.

The idea of "One Army," with a unified, consolidated organization to speak for it, was stressed at the meeting. This unification of spirit was urged, both as to major components-Regular, National Guard, and Reserves-and the separate branches and corps within the Army organization.

Secretary of the Army Brucker, as last year, was the principal speaker at the annual banquet on the night of August 5. He reviewed the far-flung commitments, accomplishments and state of readiness of today's Army in his speech, which was entitled--"This Is A Modern Army"

The intervening periods of the 3-day program consisted largely of a number of panel discussions of various phases of Modern Army development and maintenance. On the first day, following an address by General Bruce C. Clark, Continental Army Commander, on "One Modern Army", there was a panel discussion of "How We Man A Modern Army," with the Director of Selective Service, Lieut. General Lewis B. Hershey, as moderator.

The second day brought panel discussions of the topics "Modern Army Readiness Through Research," and "How We Use A Modern Army," led respectively by Lieut. General Arther G. Trudeau and the newly appointed Vice Chief of Staff of the Army, Lieut. General George H. Decker. The Honorable John J. Sparkman, United States Senator from Alabama, spoke at the luncheon meeting on the subject of "Ground Power and Diplomacy."

On the third day there was a panel discussion on "How We Support A Modern Army," headed by The Honorable Courtney Johnson, Assistant Secretary of the Army (Logistics), and a closed-circuit TV showing of the Army missile system.

Lieut General Walter L. Weible, Retired, Executive Vice President of the Association, was Master of Ceremonies.

The AUSA President, Major General Anthony J. Drexel Biddle, The Adjutant-General of the Commonwealth of Pennsylvania, presided at the annual business meeting, on August 4. Twelve resolutions were put forward at this session, which are summarized as follows:

1. To advocate an active Army of not less than 1,000,000 with a Reserve paid drill strength of 300,000 and National Guard of 400,000.
2. For accelerated provision of modernized weapons.
3. For removal of present range limitations placed on Army use of ballistic missiles systems.
4. For authorizing the Army to proceed with development and production of the NIKE-ZEUS missile system to counter enemy missile attacks.
5. To increase provisions for air-lifting and supporting the Strategic Army Corps.
6. To remove weight and range limitations on Army aircraft.
7. For re-vitalizing the Army ROTC program.
8. To establish a single basis for officer retired pay.
9. To eliminate certain legal restrictions on the employment of retired personnel in the federal government.
10. To memoralize Independence Hall, Philadelphia, the birthplace of the U.S. Army.
11.-12. Administrative matters.

Among the exhibits of modern armament and equipment there was displayed for the first time the Army's so-called "vest-pocket" Tactical Air Defense System, known as AN/MSQ-18. It consists of five trucks containing electronic detection, target tracking and fire control equipment whereby a missile battalion commander can direct and co-ordinate the fire of widely seperated missile batteries, reducing critical time factors from minutes to seconds.

Extensive exhibits of Army technical service equipment and operations were displayed and there was also a very large industrial display.

"THE SOLDIER OF TOMORROW"

A NOTEWORTHY feature of the annual meeting of AUSA in Washington this year was the presence of "The Soldier of Tomorrow" represented by a sergeant dressed and equipped in accordance with ideas of the Army's Combat Development Experimentation Center (CDEC), located at Fort Ord, California, as to the soldier of 1965. This conception, it was stated arises from the fact that "with the development of tactical nuclear weapons, their use or the possibility of their use on any future battlefield, has already conditioned the battlefield of tomorrow."

First shown at a press briefing at the start of the meeting, "The Soldier of Tomorrow" aroused considerable interest as he moved about the Sheraton-Park hotel convention rooms and halls during the 3-day session. Called to the rostrum at the annual banquet, he received congratulations from Secretary Brucker, who had him remove his helmet and mask-thus showing to the assembled delegates and guests that there was a real human inside this Man-from-Mars-like battle-dress.

The practicability of much of the equipment of the soldier, it was stated, has already been demonstrated, though some of the items are still in the development stage.

Descriptive matter furnished at the meeting stated: "This individual, capable of fighting independently or in small groups, over a wide front and in sustained operations, is a graphic portrayal of America's ultimate weapon—the man."

The soldier wears a lightweight "fully-transistorized helmet radio receiver to keep in touch with the other elements of his unit." Infra-red binoculars hinged to the helmet, along with infra-red headlights, which, it is considered, he would have on his vehicle, would enable him to see at night as well as during the day.

To spot and help him avoid enemy infra-red devices, he carries an "image metascope" slung around his neck as in the case of today's ordinary binoculars.

The exhibited soldier wore a frog-like-looking mask of grey-colored material described as for protection against the thermal effects of a nuclear attack. It was noted that the mask worn was representative only and that the design could be modified as necessary to include other provisions such as protection against toxic substances. Hands and feet are protected respectively by airtight gloves and shoes with "welded" seams, so as to prevent seepage of radioactive dust, water, etc.

For protection against flying objects, shrapnel and small arms the soldier wears a layered nylon vest and layered nylon groin armor. In case of immediate need for cover on the battlefield he might use an explosive fox-hole digger, ignite the fuse, wait for the blast, and then jump into the resulting hole in the ground. In moving over and through the nuclear battlefield, he would use "a zero ground pressure vehicle" described as either an individual "flying platform" or a crew carrying "flying car." After leaving the vehicle, he would be assisted in negotiating terrain obstacles such as streams, cliffs, etc., by his "jump belt." In that connection, the descriptive data states: "The jump belt which he himself controls will give him the ability to propel himself through the combat area at will."

The soldier carries a rifle chambered for the NATO 7.62 mm round. He does not carry a bayonet, since it is considered that hand-to-hand combat would not be involved in the type of operations envisaged. Versatility and resourcefulness, however, were emphasized by Army spokesmen, and it was noted the soldier would be familiar with the use of various weapons, and thus not limited in his knowledge of weapons and tactics to those of any one of the present-day combat arms.

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DEFENSE CHEMISTRY IN THE NEWS

(Continued from Page 23)

ing time of rocket motors empolying soild fuels to three or four times the present time of one minute or less. Asbestos powder is blended in varying proportions with a butadiene-methylvinyl pyridine copolymer. Flame temperatures inside the rocket reached 5500°F, while the outside of the rocket motor case did not get any hotter than 200°F at the end of 3.5 minutes. The material is bonded directly to the inside wall of the rocket motor.

Antiozonants for use in rubber compounding have so far been screened only by testing rubber products containing them under service conditions. A preliminary screening operation in the laboratory with simple chemicals has been devised to eliminate compounds that show no promise of being effective. The exit gases from an ozonator contain around 2% ozone and 18% oxygen. When ozone reacts with an olefin, all three of the atoms of oxygen in the ozone molecule are consumed to form ozonides. Hence the gas escaping from a solution containing an active olefin will contain all of the oxygen in the original gas from the ozonator and no ozone. When ozone reacts with a solution of potassium iodide, two thirds of the ozone is converted to oxygen, and the oxygen content of the gas is the sum of the original oxygen plus an additional volume of oxygen corresponding to that of the ozone used up. In the new test, cyclohexene is used as the olefin, and carbon tetrachloride is the inert solvent. The compound to be tested, which is expected to inhibit the olefin-ozone reaction, is also dissolved in the solvent. A stream of air containing 2% ozone is passed through this solution with cooling to O°C. The effluent is then scrubbed with potassium iodide solution and the oxygen is determined. The effect of the inhibitor in suppressing the three-atom reaction is expressed in oxygen percentage. This is compared with a standard phenylenediamine, with a set value of 100.

NEEDED INVENTIONS

The National Inventors Council, U.S. Department of Commerce, in a recent meeting asked the help of the nation's civilian inventors in producing twenty eight new devices or systems needed by the Armed Forces. Among those based on chemistry or chemical engineering, the following are typical.

Continuous cloud droplet measurement.

A sampling device for either liquid or solid particulates from a cloud, sizes ranging from 1 to 100 microns.

Methods for preventing the hardening of baked products during long-term storage.

Fungicides that are colorless, compatible with other components of finishes, stable to chemical change and actinic radiation, resistant to leaching, nontoxic to humans, and economical.

Insect repellents for personnel protection that are effective for at least twelve hours.

A dry battery performance-capability indicator which changes color or texture under the same conditions that bring about deterioration of the battery.

Equipment that will incorporate stabilizers into soils without being excessively heavy, and that will operate up to depths of two feet.

Improved plastic laminates for airplane landing mats.

Compact, accurate, rapid method for determining the freezing point of coolants in military equipment during Arctic operations.

Droplet generator or disperser operating without heating much above ambient temperatures.

INSTRUMENTATION

Air Force research has resulted in a sampling system for a mass spectrometer by which combustion processes can be studied. Combustion products are introduced by a sampling nozzle, entering under atmospheric pressure and being brought to pressures as low as 10^{-4}mm. A probe is used for this operation which contains a series of aligned orifices which are differentially pumped and which form a molecular beam from the sample. Batch analyses of gases may also be made by this instrument. Rhenium emitters as the source of ionizing electrons were also studied in the course of these investigations.

INTEREST IN PSYCHO-CHEMICALS

The possibility of using so-called psycho-chemicals in warfare-to incapacitate temporarily without permanently injuring-was given some attention in speeches at the annual meeting of the Association of the U.S. Army, held in Washington, D.C., August 3-4 and 5.

The prepared speech of Secretary of the Army, Wilber M. Brucker, for the banquet gathering on August 5, included this statement:

"The Army is doing the major portion of research and development in the fields of toxicological agents for national defense. Recently, a great deal of public interest has been shown in the possible use of chemical agents which do not cause death or permanent injury, but only produce temporary physical or mental incapacitation. Although these agents have limitations, they suggest the ultimate possibility of a new concept of warfare for which we must develop adequate defense."

Also along this line was a statement by Lieut. General Arther G. Trudeau, Chief of Research and Development, Department of the Army, in opening the panel discussion on Army research and development, on August 4.

Reviewing briefly the various areas of Army research interest, General Trudeau's paper commented as follows in respect to non-lethal gases:

"Another thought-provoking addition to our arsenal is the chemical field. If the Communists ever use chemicals with which they are equipped against us, we must be prepared to meet such an attack. On the other hand, recent tests with nonlethal gases have shown the really humane nature of such a weapon that incapacitates without killing, even leaving no harmful after effects on humans or the works of man. This is certainly an advantageous way to capture an objective without destroying needed buildings, bridges and other man-made structures".

The 3-day program did not include separate presentations by the Army's Technical Services, but they all provided exhibits. Secretary Brucker, in his banquet address, praised each of these Services for its contributions to the "Modern Army." His comments in that connection respecting the Army Chemical Corps were:

"The Chemical Corps is developing the means to protect our fighting men and equipment against the effects of chemical, radiological and biological agents which might be used by an enemy. Its efforts also have far-reaching implications for every American in this age of peril."

Letter to the Editor

THE BARCROFT WORLD WAR I HCN EXPERIMENT NOT FATAL TO DOG

THE JOURNAL *is pleased to publish here the following letter from Col. James H. Defandorf, CmlC-Retired, presenting some astonishing facts, hitherto unknown to us, about the famous Barcroft prussic acid experiment in World War I. Our reference to the incident and the statement that the dog died in the gas chamber while the man was apparently not harmed, cited by Colonel Defandorf, reflected what had been a rather widely circulated version of the story.*

In view of the circumstances related here by Colonel Defandorf, quoting Sir Joseph Barcroft, and the fact that, while the experiment took place during the course of World War I, it was not until some 15 years later that the Barcroft article, quoted by Colonel Defandorf, was published, it does not seem surprising that it came to be supposed that the dog did die.

The written reference to the incident which we had in mind particularly was contained in an article on prussic acid by J. E. Coates, Professor of Chemistry, University College, Swansea, published in the Fourteenth Edition of The Encyclopaedia Britannica, which was issued in 1929. That edition has since, of course, undergone considerable revision, and the Coates article, we now find, has been replaced by a later writing on prussic acid which does not mention the Barcroft experiment.

Colonel Defandorf, long connected with the Chemical Corps on scientific duties, is now with the Division of Medical Sciences, National Academy of Sciences-National Research Council.—Editor.

THE January-February issue of the Armed Forces Chemical Journal contained several excellent articles, and I was particularly interested in that part of your editorial " 'Psycho-Chemical Warfare' and the Case of the Discombobulated Cat" referring to the prussic acid (hydrocyanic acid; HCN) experiment of Professor (later Sir) Joseph Barcroft and the dog, as related in column 1 of page 4. The two sentences upon which I would like to comment are as follows: (1) "Barcroft remained in the chamber, so the story goes, for one and a half minutes and then came out, apparently unharmed, but he left the dog inside *dead*." (2) "The story of Barcroft, incidentally, is not confined to the scientific literature but can be found in published matter of the period intended for general circulation."

My interest in pharmacology and toxicology had made me aware, in a general way, of the nature of this experiment, but I was not familiar with the details. Hence, when I was in England during World War II, a visit to Cambridge gave me the opportunity to see Sir Joseph Barcroft and get his first-hand account of the experiment, one result of which was, to my surprise, at variance with widely quoted statements appearing in the literature. He told me that after he and the dog had been exposed in the gas chamber for a brief period the dog collapsed, apparently dead, and then laboratory attendants removed both himself and the dog from the chamber. The dog was placed outside the laboratory on a pile of rubbish and, in Barcroft's words, "when I returned to the laboratory the next morning the dog was waiting for me outside the laboratory door."

Sir Joseph later furnished me with the reference to the original article which describes the experiment, i.e.: Barcroft, Joseph: Journal of Hygiene, Vol. 31, pp. 1-34 (1931). The Toxicity of Atmospheres containing Hydrocyanic Acid Gas. This article contains the following pertinent statements: (1) "Respiration apparently ceased, animal believed to be dead, was pulled out by head," and footnote (2) "Although the corpse was set aside for burial about 6:30 P.M., the dog did in point of fact recover and was found walking about next morning. It showed no further symptoms."

It would therefore appear that the outcome of this experiment, insofar as the "death" of the dog is concerned, has not been correctly quoted in the numerous instances of its appearance in scientific literature and other published material, perhaps because reviewers or commentators did not read the footnotes of the article. However, the recovery of the dog does not in the least invalidate the experiment findings, as will be seen from these additional statements in correspondence received by me from Sir Joseph, which I feel should be quoted. " . . . . . because while in the matter of strict accuracy the animal did not die it was 'as good as dead' so far as the broad conclusions to be drawn from the experiment are concerned. There is no doubt that on the basis of that experiment it would be quiet simple to do another in which the person stayed in a little longer and the animal did not recover. It was as near as that."

"I may add what I think has been found by others besides myself, though I have not kept up with the subject. It is this, that the high toxicity of HCN in the air to dogs is due to the great effect that it has on stimulating their respiratory centers in the early stages of exposure to gas. *Injected into the circulation HCN is no more toxic to dogs than to other animals* but inhalation in dogs induces an exaggerated ventilation of the lungs and causes the absorption of larger quantities of gas in the dogs than in animals whose respiratory centres are less affected."

(*Signed*) JAMES H. DEFANDORF,
Col CmlC-Retired

CPX | OPERATION "BUY"

By
CAPTAIN PAUL A. LONGO
(CmlC USAR)

Training Exercise Conducted by New York Mobilization Designation Detachment No. 10*

TO SUCH well publicized Command Type Military Exercises as "Operation White Cloud," "Raindrop," and others is now added "BUY." This exercise to test the proficiency of the Reservists assigned to the Army Chemical Corps' New York Procurement District.

The main U. S. Army Chemical Procurement District is located at 290 Broadway, New York City. Assigned to this large military business office is a detachment of 55 Reserve Officers with previous active service in the Chemical Corps. The majority are currently employed with some of the nation's largest chemical manufacturers; others are teachers, lawyers and executives in various industries. Thus each brings to the Army a high degree of proficiency in his own field. Each has a Mobilization assignment to a specific job at the U. S. Army Chemical Procurement District, New York.

This unit was formed after World War II by the late Colonel Samuel N. Cummings, one of the developers of "Napalm" who, in order to avoid the mistakes attendant on the "crash" procurement practices of the early days of World War II, saw the advantages to the Government of a continuously trained cadre of specialists. The present senior officer is Brig. Gen. Theodore Marshall, former college professor and chemical construction engineer.

Responsibility for the training of the unit rests primarily on the Army's District Office. Here the commanding officer, Colonel Leonard C. Miller, appreciating the need for field training of a different type, has arranged for CPX "BUY" to be held at Army Chemical Center, Maryland, during this year's two week active duty session 6, July 12 thru 26.

This CPX is designed to test the operational readiness of NY Mobilization Designation Detachment No. 10. It will afford the maximum play of operational functions to insure the collection and evaluation of data under simulated war conditions related to the mission of the U. S. Army Chemical Procurement District, New York. The evaluation of resources will be linked to limitations due to probable attack damage on CONUS caused by megaton yield nuclear weapons. It will train and familiarize the Reservists in the implementation of Mobilization Plans and expanded current procurement missions under wartime conditions. The Detachment will be required to mobilize for general war. They will perform the mobilization mission of reconstituting the Procurement District to provide logistical support to the Armed Forces.

The Reservists will actually organize, in accordance with the Installation Mobilization Plans, and institute all actions necessary to carry on the procurement functions under simulated war conditions. They will operate under austere conditions and have limited records from which to operate. Their task will be to organize and staff essential elements to perform technical and administrative functions under difficult conditions imposed under a general war situation.

The Detachment has been undergoing pre-M-Day training during their regularly scheduled semi-monthly sessions. Concurrently, they are required to contact the U. S. Army Chemical Procurement District, New York, and become proficient in current operations of the District through orientation and review of current work. This supplements training received during prior years active duty periods with the Proponent Agency.

The Detachment Table of Organization for the CPX simulates the Agency's M-Day plans. Each officer is detailed to a functional element by Staff, Division, and/or Branch assignment. The pre-M-Day training presently being received by each officer is in a specific area of responsibility, in accordance with the T/D. The Procurement District has provided key personnel of the District as "Contact Representatives" for each element of the Detachment. The Reservists consult with these represenatives to obtain first hand, intimate knowledge of current policies, operations and procedures.

The CPX will encompass all activities required to reorganize a Class II installation and perform the mobilization mission. The Reserve Officers will be exposed to all types of organizational and technical problems related to such functions as installation administration, production planning, procurement, engineering, and quality assurance.

The first phase of training for NY Mobilization Designation Detachment No. 10 began in January 1959. The regularly scheduled training sessions from 6 January through 3 February were directed towards the orientation and preparatory training for the CPX. The period from 3 February through 19 May was utilized for orientation by New York Procurement District staff to their counterpart military alternates. In the final stages of training, all reservists are required to become thoroughly familiar with the actual pre-emergency actions of the District and be prepared to implement the mobilization plans during the full exercise phase of the CPX.

The New York Chemical Procurement District is unusually qualified to provide the training through this medium. The key organizational elements are staffed by civilians with Reserve Officer status assigned to Mobilization Designation Detachment No. 10. The staff includes specialists in the fields of Industrial Planning, Procurement, Engineering, Quality Assurance and Contracting. These personnel, whose ranks range from Captain to Lt. Colonel, will serve in the Control Group and as Monitors. The Commanding Officer is the Exercise Director and his Chief of Planning will serve as Chief Controller.

For the first time in the training history of the detachment, a unit exercise will be conducted away from the home grounds. Operating from a simulated Alternate Headquarters, the situations developed in the scenario will provide realism through actual unit participation in all aspects of the Mobilization mission. This CPX will become the basis for future annual unit training of the detachment.

The answer to the question of training Mobilization Designees assigned to Procurement activities is provided through this Command Post Exercise. Perhaps other units can benefit from the experience which will be gained by the NY Mobilization Designation Detachment No. 10.

*While this advance article on Command Post Exercise "BUY" was received too late for our July-August issue, it is sufficiently descriptive of the highly realistic type of procurement training for Chemical Reserve officers in the New York District, to warrant its "holdover" for this issue.—Editor.

WITH THE CHEMICAL CORPS

HEAVY WATER PLANT IN INDIANA TO BE USED BY CHEMICAL CORPS

Award of a $13.5 million contract to the Food Machinery and Chemical Corporation of New York, N.Y. for the conversion of the former Dana Heavy Water Plant of the Atomic Energy Commission at Newport, Indiana, into an Army Chemical Corps production facility was announced by the Department of the Army on August 20.

The Food Machinery and Chemical Corporation contract calls for design, construction and test operation of the facility for the production of chemical agents.

Conversion is expected to be underway by late summer and, upon completion, the Army intends to set up separate contracts for operation and maintenance of the plant. Studies indicate that it will cost $8 million less to convert the Dana plant than it would to build a complete new facility.

Plant design at Newport, as at all major Chemical Corps installations, will incorporate the ultimate in safety devices and precautions.

Situated on land owned by the Department of Defense, the Dana plant was originally built by the AEC in 1950-51, and went into operation in May, 1952. It has been maintained on a standby basis in the period since June, 1957, following the Commission's determination that the U.S. possesses an adequate stockpile of heavy water.

SCIENCE AND ASTRONAUTICS COMMITTEE REPORTS ON CBR

A compact but comprehensive and very readable report, entitled "Research in CBR-(Chemical, Biological and Radiological Warfare)" prepared by Dr. Charles S. Sheldon II, technical director, was released on August 9 by the Committee on Science and Astronautics, of the U.S. House of Representatives.

The discussion of CBR warfare, including the so-called psycho-chemicals, consist of sixteen pages, concluding with sixteen recommendations. These emphasize greater positive understanding of CBR, more positive effort in Civil Defense provisions against CBR attack, and increase in the budgetary provisions for CBR research. A 20-page Appendix to the report describes the many contributions to public health, welfare and safety which have stemmed from research activities of the U.S. Army Chemical Corps.

At the same time the Committee also released a printed statement of testimony in part before the Committee given by Major General Marshall Stubbs, his predecessor, Major General William M. Creasy, Retired, and others, pertaining to CBR.

TOP AWARD TO DR. SIM FOR RISK IN TESTING NEW CHEMICAL AGENTS

EDGEWOOD, MD., July 7—Dr. Van M. Sim, chief of the Chemical Warfare Laboratories' clinical research division at Army Chemical Center here, has been awarded the Army's highest civilian award, the Decoration for Exceptional Civilian Service.

Dr. Sim was cited for "volunteering to be the first to expose himself to several new chemical agents at the risk of grave personal injury and the direction of a program whereby over four hundred volunteers have been exposed without a single injury."

Major General Marshall Stubbs, Army Chief Chemical Officer, made the award to Dr. Sim in ceremonies here last week.

A native of Cashmere, Washington, Dr. Sim has been affiliated with the Chemical Corps since 1954. From 1954 to 1956, he was assigned to the British chemical warfare program and headed that country's human volunteer studies.

In January, 1956, Dr. Sim returned to Army Chemical Center and assumed his present duties.

A graduate of the University of Washington, Dr. Sim holds a masters degree in pharmacology from the University's graduate school. In 1944, he earned his M.D. degree from the St. Louis University School of Medicine.

He has served two terms of duty as a Naval medical officer, one during World War II, the other during the Korean War. Between the two tours, he practiced medicine in Olympia, Washington.

DR. STUBBLEFIELD RETIRES

Dr. Henry I. Stubblefield, Biological Warfare Assistant in the Office of the Deputy Chief Chemical Officer for Scientific Activities, Army Chemical Corps, retired on July 15 after more than 17 years of continuous active service with the Chemical Corps as an officer and later as a civilian.

During World War I Dr. Stubblefield served with the Navy and was honorably discharged in 1919. He was appointed a 2nd Lt. in the Chemical Warfare Reserve in March 1925. Called to active duty in 1942, his World War II service included assignments at Fort Sheridan, Illinois; Memphis General Depot; Office of the Chief Chemical Officer, Washington, D. C.; Fort Detrick, Maryland; and Allied Forces Headquarters, Italy. After VE Day he was assigned to Military Government duty in Austria as Public Health and Public Welfare Officer. On his return to the United States he served in the Special Projects Division, Office of the Chief Chemical Officer. In 1946 in the grade of Lt. Colonel he retired from active duty, but continued to serve in OCCm10 as a civilian. His duties were concerned with aspects of Research and Development in the field of Biological Warfare. He remained active in the Reserve until 1958 attaining the rank of Colonel.

Dr. Stubblefield received his M. D. from Northwestern University in 1932 and his Ph. D. from the University of Nebraska in 1926. He practiced medicine in Nebraska and Illinois until he entered military service. He is a member of Sigma Xi, a Fellow of the American Medical Association, and a charter member of the Armed Forces Chemical Association.

CANADIAN DEFENSE GROUP VISITS CHEMICAL CORPS INSTALLATIONS

Dr. John Keyston, Vice Chairman of the Defense Research Board, Canada, headed a group of key military and civilian representatives of the Army and the Defense Research Board in a six-day tour of the U. S. Army Chemical Corps installations last June. Their visit was at the invitation of Major General Marshall Stubbs, U. S. Army Chief Chemical Officer.

On the "chow line" during visit of Canadian officials to Pine Bluff Arsenal, Arkansas—Left to right: Brig. Gen. Graydon C. Essman, Commanding General, Chemical Corps Research and Development Command; Col. Russell W. Dodds, Commanding Officer, Pine Bluff Arsenal; Brig. Herbert Wainwright Love, Deputy Quartermaster General, Canadian Army; and Dr. John Keyston, Vice Chairman of the Defense Research Board, Canada.

The purpose of the visit was to enable key officials of the Canadian Department of National Defense to learn at first hand the objectives, progress and results being achieved by the Chemical Corps in providing this country with a defensive chemical and biological warfare capability.

MR. FRANK SHANTY, BALTIMORE ENGINEER, WINS FELLOWSHIP

EDGEWOOD, MD.—Mr. Frank Shanty, Baltimore chemical engineer, employed by the Army's Chemical Warfare Laboratories at Army Chemical Center here, has been awarded a Secretary of the Army Research and Study Fellowship, and will study metropolitan air pollution problems for a year at the University of Pittsburgh's Graduate School of Public Health.

Mr. Shanty joined the Laboratories in 1950, and is currently chief of the engineering design section of the protective development division.

Mr. Shanty was graduated from Johns Hopkins University in chemical engineering in 1943 He served in the Navy during World War II.

COL. GREEN NEW COMMANDANT OF CHEMICAL CORPS SCHOOL

Colonel William H. Green, who has been serving as Chemical Officer, Headquarters Pacific, Hawaii, has been assigned as Commandant of the Chemical Corps School, Fort McClellan, Alabama. He replaces Colonel Carl V. Burke, Commandant since July 1956, who takes over Colonel Green's former duties in Hawaii.

Colonel Green served as Chemical Officer of the XXth Corps in the European theater of operations in World War II, and subsequently as Commanding Officer of Pine Bluff (Arkansas) Arsenal.

COLONEL ARTHUR DEPUTY C.O. OF TRAINING COMMAND

The assignment of Colonel Frank M. Arthur, as Deputy Commanding Officer, U.S. Army Chemical Corps Training Command, has been announced by Colonel John M. Palmer, Commanding Officer.

Colonel Arthur, who joined the Army in 1931, served during World War II as Chemical Officer of the 41st Infantry Division and the I Corps. He participated in four campaigns in the Southwest Pacific area.

A graduate of George Washington University with a Master's Degree in Business Administration, Colonel Arthur has attended the Command and Staff College of the Army and has just recently been graduated from the National War College in Washington, D.C.

His last previous assignment was in the Office of the Chief Chemical Officer as head of the Career Management Division.

CIVILIAN AWARDS

Outstanding Performance Awards, including cash, were made recently in the Office of the Chief Chemical Officer to: **Mrs. Alverta J. Mauck,** Logistics Planning Division, and **Mr. James D. Edwards**, Office of Assistant Chief Chemical Officer for Planning & Doctrine.

Awards to four civilian employees in the Office of the Chief Chemical Officer were presented recently as follows-*Sustained Superior Performance* awards plus cash to: **Evelyn W. Zimmerman,** Provost Marshal's Office, and **Mildred T. Hunter,** Comptroller's Office; and

Outstanding Performance Appraisal awards plus cash to: **John P. Coyle,** Planning and Doctrine Office, and **Wilma M. Carver,** Logistics Planning Division.

CHEMICAL CORPS CUTS COSTS

Through use of modern electric accounting machine methods and automatic typewriters, the U. S. Army Chemical Corps, in only a minor segment of its operations, was able to effect an annual savings of $13,400 and to release about $50,000 worth of equipment for use by other Army elements.

The preparation of supply manuals or catlogs on Chemical Corps equipment was a time consuming and expensive process, liable to human error at several stages. Under the previous system all supply records were manually prepared, and the preparation of manuscripts involved transcribing voluminous data by hand.

After a study of several possible systems, a semi-automatic system using electric accounting machines and automatic typewriters was adopted, enabling reduction in personnel and release for other use of approximately $50,000 worth of equipment.

The $13,400 annual savings is sub-divided as follows: savings in floor space, $2,100; personnel, $7,700; time, $900; overtime previously required, $700; and costs for type-setting copy, no longer necessary, $2,000.

CBR DEFENSE SCHOOL IS CONDUCTED AT ALASKA POST

FT. RICHARDSON, ALASKA.—A school is operating at Fort Richardson to teach U.S. Army, Alaska officers and selected noncommissioned officers a subject which got its initial beginning more than 400 years B.C., and its latest start in 1944.

The subject—Chemical, Biological, Radiological warfare defense.

Under command of Captain George M. Alter, Fort Richardson chemical officer, the school covers all phases of CBR to give students a background in the "ancient-modern" techniques of CBR defense, and qualify them as instructors for their home units.

Radiological subjects, the newest of the three, is covered by Master Sergeant Paul Grosh. Private First Class Vernon Velez handles instruction in nuclear survey instruments. Both instructors teach other subjects which include smoke and flame apparatus, chemical and biological agents, and the effects of thermo-nuclear weapons.

"We combine theory with practical work during classes," Captain Alter said, "to show as well as explain what CBR agents can do, and what a lack of this knowledge could mean on the battlefield. Before each course ends, every student has a clear view of the entire CBR picture."

FT. RICHARDSON, ALASKA—Exposed arm of Chief Warrant Officer Dorris C. Goodman, 80th Trans. Co., shows the three circles which are part of the mustard gas test.

Chemical warfare actually started in 428 B.C., so history relates, when the Greeks laid seige to the Spartan city of Platea. They used firebrands of pitch and sulphur, threw the noxious torches over the city walls, and literally smoked the Spartans out into the open.

NEW YORK CHEM. CORPS RESERVES CONDUCT UNIQUE EXERCISE AT ACC

ARMY CHEMICAL CENTER, MD.,—Chemical Corps Reserve Officers, members of the New York Procurement District Mobilization Detachment, conducted a two-week active duty training encampment here during July. These reservists, some 40 strong, carried out an intensive program of mobilization training under the most realistic of simulated wartime conditions.

Capt. Paul Longo, member of the New York Reserve Officer detachment which waged simulated war at Army Chemical Center last July, examines a scale model of a chemical agent manufacturing plant.

The exercise was called "MatCom CPX-60," and covered all phases of wartime large scale procurement of the thousands of items for which the Army Chemical Corps is responsible to furnish to members of the Army, Navy, Air Force, and Marines.

Most of the members of the unit have previous World War II and Korea experience. All are business or professional men. Theirs was the problem of setting up and operating, for two weeks, a procurement office here, and coordination of all procurement of Chemical Warfare materiel under conditions which assumed that such major cities as New York had previously been immobilized by enemy action.

According to Army records, this was the first time a training exercise of such magnitude and realism had been undertaken for reservists by the Army Chemical Corps.

Brigadier General Harold Walmsley, commander of the Chemical Corps' Materiel Command, with headquarters here, feels that this exercise and its results will be most helpful in even further streamlining of the Materiel Command's mobilization plans to assure greater combat readiness. (See article by Capt. Longo, page 32.)

CRUMB, A VICE PRESIDENT OF INDUSTRIAL COLLEGE ALUMNI

Mr. Edgar A. Crumb, Executive Director, Office of the Chief Chemical Officer, U. S. Army, an alumnus of the Industrial College of the Armed Forces, has been elected 2nd Vice President of the Alumni Association of the College. Mr. Crumb attended the College in his civilian capacity. He formerly served in the Marine Corps, and now holds a Reserve Commission as a Lieutenant Colonel in the Chemical Corps.

HEADS WOMEN'S CLUB AT PINE BLUFF ARSENAL, ARK.

Mrs. Buford B. A. Semmes, (picture herewith) wife of Captain Semmes, director of depot operations, was recently elected chairman of the Pine Bluff Arsenal Women's Club.

Mrs. Russell W. Dodds, wife of Colonel Dodds, Arsenal commanding officer, is honorary chairman. Other officers are: Mrs. Francis M. Robertson, vice chairman; Mrs. John J. Berky, treasurer; and Mrs. James Gray, secretary.

SGT. BOUTIN WINS RIBBON

Sergeant First Class Jean G. Boutin, son of Mr. Paul E. Boutin, 347 Spruce Street, Manchester, New Hampshire, currently assigned to the Military Personnel Branch in the Office of the Chief Chemical Officer, Washington, D. C., has been awarded the Army Commendation Ribbon with Metal Pendant by Army Chief Chemical Officer, Major General Marshall Stubbs.

Sergeant Boutin was cited for his meritorious services while assigned to the Officers Personnel Section at Fort Detrick, Maryland. He has been in the Army 16 years.

AIDE TO GEN. WALMSLEY

ARMY CHEMICAL CENTER, MD.—First Lieutenant Clyde E. Goodyear, son of Mr. and Mrs. Willis Goodyear of 3128 Taylor Terrace, Philadelphia, has been named aide-de-camp to Brig. General Harold Walmsley, commanding general of Army Chemical Center and the Chemical Corps Materiel Command here.

A liberal arts major at LaSalle, Lt. Goodyear was commissioned into the Artillery through the University's ROTC in 1955. He comes to the Army Chemical Center from an assignment with the 14th Infantry Division at Fort Benning. In April, 1958, Lt. Goodyear was tendered a Regular Army commission in the Chemical Corps.

TOP STUDENTS CONGRATULATED

Chief Chemical Officer Major General Marshall Stubbs, congratulates the top three students in the 13th Chemical Officer Advanced Class; from right, Captains John P. Byrne, Harold E. Shaw, and Elwood A. Lloyd, during graduation ceremonies in the Chemical Corps School, Fort McClellan, Ala.

GIRL WHO WOULD BE DOCTOR WINS ENLISTED SPECIALIST CLUB AWARD

Rosalie Ann Laurie, a graduate of Havre de Grace (Maryland) Consolidated High School, receives formal notification of her selection as recipient of the Army Chemical Center's Enlisted Specialists Club's seventh annual scholarship from club president, Private First Class Clifford Monzeglio. Mr. Leon S. Roye, school principal, looks on. She plans a career in medicine.

GROUP AND SUSTAINING MEMBERS

OF THE ARMED FORCES CHEMICAL ASSOCIATION

Abbott Laboratories, North Chicago, Ill.
Adache Associates, Inc., Engineers, Cleveland, Ohio
Air Reduction Company, Inc., New York, N.Y.
Allied Chemical Corporation, New York, N.Y.
American Cyanamid Company, New York, N.Y.
American Potash & Chemical Corporation, 300 West Sixth, St., Los Angeles 54, California
American Zinc, Lead & Smelting Co., St. Louis, Mo.
Armour & Company, Chicago, Ill.
Armstrong Cork Company, Lancaster, Pa.
Astra Pharmaceutical Products, Inc., Worcester 6, Mass
Atlas Powder Company, Wilmington, Del.
Barnebey-Cheney Company, Columbus, Ohio
Bechtel Corporation, San Francisco, Calif.
Bell & Gossett Company, Morton Grove, Ill.
Blaw-Knox Company, Pittsburgh, Pa.
Brothers Chemical Company, 575 Forest St., Orange, N.J.
Brown Company, Berlin, N.H.
Casco Products Corporation, Bridgeport, Conn.
Celanese Corporation of America, New York, N.Y.
City Chemical Corp., New York, N.Y.
Columbia-Southern Chemical Corp., Pittsburgh, Pa.
Commercial Solvents Corporation, New York 16, N.Y.
Continental Can Co., Inc., Chicago, Ill.
Continental Oil Co., Ponca City, Okla.
Crane Co., Chicago, Ill.
Diamond Alkali Company, Cleveland, Ohio
Dow Chemical Company, Midland, Mich.
E. I. duPont de Nemours & Co., Inc., Wilmington, Del.
Edo Corporation, College Point, N.Y.
Engelhard Industries, Newark, N.J.
Esso Research and Engineering Co., New York, N.Y.
Evans Research & Development Corp., New York, N.Y.
Federal Laboratories, Inc., Saltsburg, Pa.
Ferguson, H. K., Company, The, Cleveland, Ohio
Ferro Corporation, Cleveland, Ohio
Firestone Industrial Products Co., Fall River, Mass.
Fisher Price Toys, Inc., East Aurora, N.Y.
Fisher Scientific Co., New York, N.Y.
Fluor Corporation, Ltd., The, Whittier, Calif.
Food Machinery & Chemical Corporation, New York, N.Y.
Foster Wheeler Corporation, New York, N.Y.
Fraser & Johnston Co., San Francisco, Calif.
General Aniline & Film Corporation, New York, N.Y.
General Electric Company, Chemical & Metallurgical Division, Pittsfield, Mass.
General Tire & Rubber Company, The, Wabash, Ind.
Goodrich, B. F., Chemical Company, Cleveland, Ohio
Handy & Harman, New York, N.Y.
Harshaw Chemical Company, The, Cleveland, Ohio
Harvey Aluminum, Torrance, Calif.
Hercules Powder Company, Wilmington, Del.
Heyden Newport Chemical Corporation, New York, N.Y.
Hooker Chemical Corporation, Niagara Falls, N.Y.
Industrial Rubber Goods Company, St. Joseph, Mich.
International Nickel Co., Inc., New York, N.Y.
International Salt Co., Inc., Scranton, Pa.
Kennecott Copper Corporation, New York, N.Y.
Lambert-Hudnut Mfg., Laboratories, Inc., Lititz, Penna. subsidiary of Warner-Lambert Pharmaceutical Company, St. Louis, Mo.
Eli Lilly and Co., Indianapolis 6, Ind.
Little, Arthur D., Inc., Cambridge, Mass.
Lummus Company, The, 385 Madison Ave., New York, 17, N.Y.
Mason, L. E., Company, Hyde Park, Mass.
Merck & Company, Inc., Rahway, N.J.
Mine Safety Appliances Co., Pittsburgh, Pa.
Minnesota Mining & Manufacturing Co., 900 Fauquier Avenue, St. Paul, Minnesota
Miracle Adhesives, Corp., 250 Pettit Ave., Bellmore, Long Island.
Monsanto Chemical Company, St. Louis, Mo.
National Cylinder Gas Co.—Chemical Div., Chicago 11, Ill.
Niagara Blower Co., New York, N.Y.
Olin Mathieson Chemical Corp., East Alton, Ill.
Oronite Chemical Company, San Francisco, Calif.
Pemco Corporation, Baltimore, Md.
Pennsalt Chemicals Corporation, Philadelphia, Pa.
Pfizer, Chas. & Company, Inc., Brooklyn, N.Y.
Pfaudler Company, a Division of Pfaudler Permutit, Inc., Rochester 3, New York
Phillips Petroleum Company, Bartlesville, Okla.
Pittsburgh Coke & Chemical Co., Pittsburgh, Pa.
Proctor & Gamble, Cincinnati, Ohio.
Reynolds Metals Company, Louisville 1, Ky.
Shea Chemical Corp., Jeffersonville, Ind.
Shell Chemical Corp., Denver, Colo.
Shell Development Company, Emeryville, Calif.
Sheller Mfg. Co., Dryden Rubber Div., Chicago, Ill.
Shwayder Bros., Inc., Denver, Colo.
Standard Oil Company (Indiana), Chicago, Ill.
Stauffer Chemical Company, New York, N.Y.
Sun Oil Company, Philadelphia, Pa.
Union Carbide Corporation, New York, N.Y.
United-Carr Fastener Corp., Cambridge, Mass.
Universal Match Corp., Ferguson, Mo.
United States Borax & Chemical Corp., 630 Shatto Place, Los Angeles 5, Calif.
Vitro Corporation of America, New York, N.Y.
Vulcan-Cincinnati, Inc., 120 Sycamore St., Cincinnati 2, Ohio
Wigton-Abbott Corporation, 1225 South Avenue, Plainfield, N.J.
Witco Chemical Company, Chicago, Ill.
Wyandotte Chemicals Corp., Wyandotte, Mich.

Companies listed in bold face type are Sustaining Members

GOOD TIME FOR HARD LOOKS

at needless chlorine costs

Columbia-Southern's manufacturing and servicing experience with quality chlorine may help you achieve appreciable savings on former costs. Isn't this the ideal time to see if your chlorine purchase and use practices aren't costing more than necessary?

Let's take the *quantity* of chlorine you are currently buying and handling. Is your operating volume most economically adapted to tank car, barge, ton tank, or cylinder delivery? Are you quite sure that new or projected changes in your products or processing won't change this picture? Do you have all the facts on completely up-to-date unloading techniques and equipment?

Let's look at the uniform *quality* of the chlorine you are receiving. Here again, Columbia-Southern can advise you with recognized authority as the country's leading merchant producer. As a matter of record, we have led in developing such vital improvements in chlorine transportation as the fusion-welded tank car, the 55-ton single unit car, the safety-dome platform, the industry's first large capacity barge fleet for inland waterways delivery, and other user economies or safety features.

Our well-grounded Technical Service specialists, too, have helped customers save on needless chlorine costs. One valuable aid, for example, is their extremely thorough yearly inspection of your unloading, storage, and use operations. Isn't it simple good business, especially now, to see what savings they might work out for you? You may request their services either through our Pittsburgh address, or any of the fourteen Columbia-Southern District Sales Offices.

The Columbia-Southern Chemical Corporation, One Gateway Center, Pittsburgh 22, Pennsylvania. Offices in principal cities. In Canada: Standard Chemical Limited.

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